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STRATEGY FOR IMPROVEMENT OF DON RIVER WATER QUALITY

SUMMARY REPORT

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Environment Ontario

Jim Bradley
Minister

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TORONTO, ONTARIO [illegible]

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Strategy for improvement of
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summary report /

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STRATEGY FOR IMPROVEMENT OF DON RIVER WATER QUALITY

SUMMARY REPORT

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Steering Committee
Toronto Area Watershed Management Study

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FOREWORD

In 1981 the Ontario Ministry of the Environment (MOE) began a study of water quality in the Don River, Humber River and Mimico Creek to provide baseline data to guide future studies. The following year the Toronto Area Watershed Management Strategy Study (TAWMS) was initiated as a comprehensive and co-operative multi-agency undertaking towards the attainment of water quality improvements.

The TAWMS study objectives are:

- To better define water quality conditions with the study area;
- To analyse the cause and effect relationships for problem constituents and areas; and
- To develop cost-effective measures for controlling pollutant loadings to the study area's receiving waters based on watershed needs and users.

Although wholly funded by MOE, TAWMS receives extensive co-operation and support from the Metropolitan Toronto and Region Conservation Authority (MTRCA), Metropolitan Toronto and area municipalities.

The TAWMS study is managed by a Steering Committee which includes representatives of the following agencies:

Ontario Ministry of the Environment
Ontario Ministry of Natural Resources
Metropolitan Toronto & Region Conservation Authority
Environment Canada
Metropolitan Toronto
Borough of East York
City of Etobicoke
City of North York
City of Scarborough
City of Toronto

City of York
Regional Municipality of York
Regional Municipality of Peel
Town of Richmond Hill
Town of Vaughan
Town of Markham

A detailed study of the Humber River was carried out during the period 1982 to 1985. In 1986, the TAWMS Steering Committee released a Management Plan for the Humber River. Recommendations which were outlined in this plan are presently being implemented.

The TAWMS Don River Water Quality Improvement Study was commissioned as an external contract to Paul Theil Associates Limited and Beak Consultants Limited in the spring of 1988. The study's mandate was to summarize water quality problems, relate these problems to sources and to provide a range of remedial actions leading to various levels of control for water quality improvements. Options investigated for water quality improvement range from no further degradation to the full restoration of water quality in the Don River.

The improvement strategy incorporates findings from intensive investigations of low flow and storm event conditions, snow melt, the status of biological communities and general water quality conditions.

The Steering Committee instructed the consultants to present their findings as alternative or staged management strategies which will lead to several milestones or levels of water quality improvement.

Public consultation on a number of strategies for water quality improvement for the Don River, combined with inputs from a range of municipalities and agencies will provide valuable direction for drafting the final Don River Management Plan. Improvement strategies outlined in this report for the Don River and for other rivers which drain into the waterfront will be considered in context of the Metro Toronto Remedial Action Plan (RAP), a provincial-federal initiative for protecting water quality in Toronto's waterfront.

Implementation considerations and costs are important components in this option selection/consultation process, since they identify in simple terms what it will take to achieve a range of improvements and benefits or designated uses of the Don River. This consultation process will also recognize the will of municipalities, government agencies, developers and the public to support selected undertakings to protect and enhance water quality in the Don River.

The time span in which water quality improvements are to be derived and the ultimate costs will depend upon the levels of protection and the phasing of controls selected on the basis of public feedback and agency and municipality endorsement. It is recognized that effective improvement actions in the Don River watershed will also require creative solutions and new approaches by the municipalities and government agencies.

In addition to the remedial measures proposed in the strategy a number of immediate actions are presently underway to address water quality problems by means of regular municipal and conservation authority works and maintenance programs, or through Ministry of the Environment programs such as the Waterfront Water Quality Improvement Program which funds physical work on the watercourses, waterfront or sewers yielding immediate benefits.

In releasing this report the TAWMS Steering Committee and Environment Ontario seeks public comment on the acceptability of the recommended remedial measures, direction as to appropriate benefits/use of the Don River and implementation (scheduling and agency responsibility).

Comments on this report, desired improvement strategies and time frames for implementation are welcome. Please send written comments to:

Toronto Area Watershed Management STudy
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Toronto, Ontario
M4V 1P5

ABSTRACT

As a part of the Toronto Area Watershed Management Strategy Study (TAWMS) and as an extension of other studies (Comprehensive Basin Management Strategy for the Rouge River Watershed), the major objectives of this study were:

- to identify the water quality problems within the Don River,
- to define the relative contribution from each source of pollution,
- to evaluate the effectiveness of various remedial and mitigative measures for improving water quality and provide associated cost estimates,
- to develop a framework for evaluating the response of aquatic toxicity and the fishery to these measures in the context of an ecosystem-based plan, and
- to recommend a strategy for improving the water quality of the Don River.

A spreadsheet model using loading-dilution mass balance principles was used to evaluate the response of six parameters (total phosphorus, suspended solids, copper, lead, fecal coliforms, ammonia) to remediation. Eleven study reaches were evaluated with priority given to the upper watershed, the middle watershed, the lower watershed and Massey Creek.

The response of water quality to remediation of a variety of sources (spills, erosion control, sewer use bylaw, agricultural control) was evaluated qualitatively. The potential response of aquatic toxicity and the fishery to remedial and mitigating measures were evaluated with quantitative models, but interpreted qualitatively. Special emphasis was placed upon the impact of spills remediation and upon integrating remediation into an ecosystem approach involving water quality, public health, public safety, aquatic toxicity, the instream fishery riparian vegetation and terrestrial habitats for water fowl and wildlife.

A strategy for improving water quality was developed. Priorities for controls of specific sources of pollution (stormwater, combined sewer overflows (CSO's), Sewage Treatment Plant (STP)) were established by examining their impact upon dry weather conditions (70% of the time), small events (5 mm or less; 15% of the time) and large events. Priorities were also established by examining their impact upon a guild of beneficial end uses including the fishery, aesthetics, contact and non-contact recreation, and reduction

in loadings to Lake Ontario. Priorities for mitigative measures for the fishery were established from the Habitat Suitability Index (HSI) analysis. Priorities for aesthetics were based upon judgement and consultation with the TAWMS Technical Committee.

In the past various works have been carried out which have reduced the pollutant load to the Don River. The major works include:

- o removal of localized Sewage Treatment Plants;
- o identification and removal of direct sanitary discharges from residential, commercial and industrial areas;
- o construction of stormwater management facilities in areas recently developed;
- o reduction in frequency and magnitude of combined sewer overflows; and
- o construction of works to minimize erosion and sedimentation.

The major cause of water quality degradation under present day conditions was found to be discharges from separated storm sewers. The recommended strategy is therefore focussed around:

- o controlling of urban runoff with wet ponds or equivalent, and
- o infiltrating of stormwater runoff into the ground.

To achieve swimming objectives, disinfection of stormwater runoff is also required. Ultimately, three management strategies are required.

1. implementation of wet ponds or equivalent in all <u>new developments</u>, in conjunction with disinfection;

2. infiltration of stormwater as <u>redevelopment</u> opportunities occur in existing developments, and in new developments were soil conditions are appropriate; and

3. retrofitting <u>developed</u> areas with wet ponds or equivalent and disinfection.

The overall strategy is divided into three phases: immediate (1989-1990), Phase 1 (5-10 year time frame) and Phase 2 (10-50 year time frame).

In addition to the above, other new mitigative measures which are recommended are designed to have a significant impact upon the fisheries and aesthetics. As well, they will have a high visual impact upon the public and associated public relative benefits for all concerned. These include riparian zones along water courses, a demonstration Conservation reserve, clean-up of debris, and demonstration projects to establish a "natural" channel with fish habitat and an urban fishery in an appropriate tributary.

Further measures included in the strategy are existing source control measures (cross-connection detection), CSO control, STP upgrading, public education to improve control of household chemicals, and an enhancement of spills control efforts. As well, further work needs to be undertaken to improve our understanding of complex water quality issues.

In terms of implementation, work is required to better establish the recommendations of this study and to investigate other factors in addition to cost and effectiveness. These include technical feasibility (e.g., for disinfection, availability of land for wet ponds), municipal and public acceptability, environmental assessment (implications), legal and jurisdiction considerations, ecosystem integrity with economic development and relationships to other programs (e.g., Toronto Remedial Action Program, RAP).

In this context, a program is proposed for implementing and auditing the achievement of water quality objectives, especially related to stormwater, as other programs such as Municipal Industrial Strategy for Abatement of Pollution (MISA) will not involve stormwater. It would also be useful to develop an integrated water management plan for the Don River to incorporate fisheries, water quality, flood protection, erosion control, landscape values, terrestrial habitat and other social and environmental amenities. The foundations for this plan have been provided by this present study.

With respect to implementation, several immediate actions are required. They include:

- control of runoff from new developments with wet ponds or equivalent,
- demonstration projects for specific areas,
- restoration of riparian vegetation and other aesthetic improvements,
- improvement of several source control programs,
- continuation and/or acceleration of existing programs related to water quality (e.g., erosion and sediment control, cross connection programs).

The estimated cost for the strategy has been established. Estimates have been determined for various levels of water quality improvement and include costs for the continuation of existing programs and for proposed programs. The estimated costs for the proposed programs in order to attain various beneficial uses (which in turn reflect different levels of water quality improvement) are given below. Tables 5 and 6 describe in more detail, the information which is provided below.

Degree of Protection	Annual Cost ($million/yr.)	Present Value Cost ($ million)
1. Status Quo	4-5	65-80
2. Limited Aesthetics and Water Quality Improvement	12-15	200-250
3. Substantial Water Quality Improvement	17-27	300-450
4. Partial Body Contact in All River Areas and Other Improvements	28-36	450-600
5. Fully Acceptable Water Quality	45-56	750-900

In general, the estimates indicate that the additional costs for the recommended strategy are less than those associated with present remedial programs, which are of the order of $75 million/year or $1,200 million on a present value basis (50 year period). Many of these expenditures for new measures would occur for only a 10-20 year time frame rather than for a long (i.e. 50 year) time frame, since 10-20 years are required to implement most of the measures.

The estimated costs of the existing and proposed programs may be compared to the benefits received by the public.

The annual cost per household for the proposed programs range from$20 to maintain status quo to $220 to attain water quality standards which would substantially increase aesthetics, fishing and body contact recreation. In addition to overall water quality improvement, social and environmental amenities would also be enhanced due to proposed construction of large scale water quality ponds (reference may be made to Figures 2 through 5 in the text).

The above estimates may be compared to intrinsic values of $100 per household per year placed by citizens for improved water quality (fishable and/or swimmable waters). The estimate for benefits to the public were obtained from a 1988 Remedial Action Plan study funded by MOE's Policy and Planning Branch.

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STRATEGY FOR IMPROVEMENT
OF DON RIVER WATER QUALITY

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GLOSSARY OF ACRONYMS

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1. Study Scope and Purpose

1.1 Background

The Ontario Ministry of the Environment (MOE) initiated a study of water quality in the Don River, Humber River and Mimico Creek in 1981 to provide baseline data to guide future studies. Subsequently, the Toronto Area Watershed Management Strategy Study (TAWMS) was formally organized. The objectives of TAWMS as outlined in the 1986 Report in the Humber Water Quality Management Plan are:

- To better define water quality conditions within the study area;
- To analyse the cause and effect relationships for problem constituents and areas; and
- To develop cost-effective measures for controlling pollutant loadings to the study area's receiving waters based on watershed needs and uses.

Initial emphasis was placed on studies of the Humber River watershed during 1982 through 1985. Mimico Creek was studied in 1982 and 1983 while the Don River was studied from 1984 to 1987. A Water Quality Management Plan has been prepared for the Humber River. The emphasis on the Don River, to date, has included collection of water quality data to provide background information.

At present there are a variety of remedial programs currently in place within the Metropolitan Toronto area. Remedial programs underway were instituted through normal municipal practices or through one of four programs.

i) TAWMS: Toronto Area Watershed Management Strategy;
ii) WWQIP: Waterfront Water Quality Improvement Program;
iii) MISA: Municipal-Industrial Strategy for Abatement;
iv) IRP: Infrastructure Rehabilitation Program;

Another watershed study, the MTRCA's Comprehensive Basin Management Strategy for the Rouge River study was initiated independent of TAWMS and is broader in scope (fisheries, flood control, terrestrial habitat) than previous TAWMS study plans. Other programs which will influence remediation in the future include:

i) RAP: Toronto Remedial Action Plan; and

ii) Ministry of the Environment Lifelines Program.

The overall area of stormwater quality management will also require attention, as it is not currently covered by MISA.

A summary of the quantitative findings of this study are given in the appendix to this summary report. Five supporting documents, on file, contain the remainder of the study methodology as follows:

Supporting Document 1: Contains a description of the sources of contaminants to the river and of the calibration of the spreadsheet loading model.

Supporting Document 2: Describes an evaluation of the present fishery of the Don River, the impact of aquatic toxicity upon the fisheries, and the potential response of aquatic toxicity and the fishery to water quality improvement.

Supporting Document 3: Describes a methodology for evaluating the response of water quality to spills remediation and the costs and effectiveness of other control measures.

Supporting Document 4: Contains a summary of existing water quality characteristics, identifies sources of problems, and relates these to stakeholders concerns and PWQO's.

Supporting Document 5: Detailed Analysis of Existing Water Quality Data

1.2 Study Objectives

The intent of this study is to build upon the existing data base which has been gathered for the Don River. The major objectives may be defined as follows:

o Identify the water quality problems within the Don River.

- o Define the relative contribution from each source of pollution (i.e., storm sewer runoff, sewage treatment plant flows, combined sewer overflows, etc.).
- o Evaluate the effectiveness of various mitigative options for improving water quality and provide associated cost estimates.
- o Recommend a strategy for improving the water quality of the Don River.

1.3 Study Methodology

The approach to this study involved the utilization of results from many sources including reports and water quality data relating to the Don, Humber and Rouge Rivers and external sources (principally the extensive water quality data base as prepared by the United States Environmental Protection Agency). These findings were then combined with a simplified method of analysis, including qualitative assessments where necessary, to establish a recommended strategy for water quality improvement. The simplified method of analysis evaluated different scenarios of control options to assist in formulating the strategy.

1.4 Presentation of Study Results

The results of this study have been incorporated into this document and five Supporting Documents entitled:

i) Quantitative Methodology for Estimating Response of Don River to Water Quality Control;

ii) Framework for Evaluating Response of Aquatic Toxicity and Fish Habitat to Water Quality Control in the Don River;

iii) Methodology for Evaluating Impacts of Spills Remediation and Other Remedial Options Upon Don River Water Quality;

iv) Assessment of Don River Water Quality; and

v) Detailed Analysis of Existing Water Quality Data.

1.5 Sources of Contaminants

The Don River watershed is highly urbanized (approximately 70 percent). The river and associated tributaries are subject to various potential sources of pollution including:

- storm sewer discharges,
- combined sewer overflows (Cities of Toronto and Scarborough; Borough of East York),
- spills,
- flows from the North Toronto Sewage Treatment Plant STP,
- cross connections between sanitary and storm sewers,
- snow dumps,
- landfill sites,
- agricultural and rural sources,
- stream bank erosion,
- construction activity, and
- atmospheric fallout.

1.6 Present Water Quality

As a result of the various sources of pollution, the instream water quality throughout most of the watercourse is considerably degraded. The pollutant concentrations tend to be higher near the mouth of the river due to the higher level of urbanization and the presence of a sewage treatment plant and combined sewer overflows.

The water quality data for the 1980's indicate that the river is often turbid, and eutrophic. It has high bacterial counts and high temperatures in the summer. The river has plentiful oxygen resources with few observations below 6 mg/L. This indicates that treatment efforts for control of oxygen demanding substances over the past two decades have been successful for meeting water quality objectives. The river may be toxic to fish in the lower reaches downstream of the North Toronto STP due to ammonia and total residual chlorine discharges from the STP. Toxicity due to metals or organic chemicals are plausible but uncertain due to sorption onto suspended solids and a paucity of data. In place pollutants may be problematic in the Keating Channel in which may pose an effect on salmonoid fish migration. The fishery quality is poor. This is due to habitat/hydrologic and water quality factors.

The level of degradation may be assessed by comparing the percentage of time the concentration of a specific water quality parameter exceeds the guidelines or objectives as established by the Ministry of Environment or other agencies (i.e., United States

Environmental Protection Agency). Several comparisons of instream water quality concentrations to Provincial Water Quality Objectives (PWQO's) are given below.

Water Quality Parameter (Target Value)	Percentage Exceedence	Location
Total Phosphorus (0.03 mg/L)	99-100%	Lower Don
	80-90	East Don
	99-100	West Don
Fecal coliform (100 counts/100 mL)	75-96	Lower Don
	89-96	East Don
	60-80	West Don
Copper (0.005 mg/L)	80-90	Lower Don
	30-40	East Don
	60-70	West Don
Lead (0.025 mg/L)	11-28	Lower Don
	9-17	West Don
	3-10	East Don

The "Lower Don" is the water quality monitoring station of the Don River at Lakeshore, the "East Don" is the station on the East Don River at Bayview and Steeles. The "West Don" is the station on the West Don River at Sheppard (see Figure 1).

1.7 Beneficial Uses

Previous documents have suggested that due to the level of degradation and other factors such as channelization and removal of riparian habitat and canopy, few of the original species of fish remain today. However, despite the impacts of urbanization, several species (white sucker, blacknose dace, longnose dace and creek chub) still remain. Furthermore, the physical habitat of the river is such that if water quality conditions were improved, an improved fishery could be re-established.

In addition to supporting a quality fishery, several other existing or potential beneficial uses of the Don River were identified. These include:

- non-contact recreation (boating, canoeing),

the metropolitan toronto and region conservation authority

DON RIVER WATERSHED
FIGURE 1

----WATERSHED BOUNDARY

- o contact recreation (wading, swimming),
- o aesthetics (i.e., improving water clarity, reducing frequency of spills and reducing the presence of odours, oil slicks and debris),
- o reducing the pollutant load to Lake Ontario, and
- o reducing loadings of toxic substances.

1.8 Evaluation of Cause-Effect Relationships

In order to establish the feasibility of providing any or all of the beneficial water uses, the instream water quality concentrations and loadings were estimated at the following locations along the watercourse (see Figure 1).

- o West Don above Langstaff (as representative of the Upper Don);
- o West Don at Confluence with East Don (as representative of the Middle Don);
- o Massey Creek; and
- o Lower Don at junction with Keating Channel (as representative of the Lower Don).

Concentrations and loadings were estimated for total phosphorus, fecal coliforms, ammonia, lead, copper and suspended solids. These parameters were selected as sufficient background data were available and they impact several of the beneficial uses as described above (for example, suspended solids are used as an indicator in assessing aesthetics; they also impact fisheries; fecal coliforms are used as an indicator for contact recreation). Other parameters do describe the beneficial use of the water course but insufficient modelling methodologies and estimates of loadings are available to describe the response of the system to their control.

The concentrations and loadings for the above parameters were estimated for dry weather periods and for a series of wet weather events to determine the relative importance of different pollutant sources for different conditions.

1.9 Levels of Improvement of Water Quality

In order to better establish the feasibility of attaining specific beneficial uses, the following was carried out:

- o existing water quality conditions (status quo) were established;
- o levels of water quality, which relate to specific beneficial uses, were selected; and
- o various mitigative options and their effectiveness in reducing pollutant loads were identified.

Ultimately, five potential levels of water quality were selected. Initial efforts, in consultation with Ministry of Environment professionals, established the following levels of protection.

Level	Level	Water Quality Parameters of Concern	Degree of Water Quality Control
1	No Further Degradation	o all parameters	o maintain status quo.
2	Aesthetic Improvement	o total phosphorus, suspended solids, oil, grease	o mitigation of local problems. o improve smell, colour. o reduce visible solids, debris, etc.
3	Urban Warm Water Fishery Non-Body Contact Recreation	o fecal coliforms o dissolved oxygen, suspended solids, temperature, pH	o meet MOE guidelines for swimming part of the time o ensure non-toxic conditions
4	Partial Body Contact in All River Areas and Other Improvements	o fecal coliforms o dissolved oxygen, suspended solids, temperature, pH	o meet PWQO's much of the time
5	Fully Acceptable Water Quality	o all parameters	o meet standards for virtually all conditions (except for severe rainfall events)

Due to difficulty of determining whether aesthetics, a healthy fishery or a swimmable water describes more stringent water quality conditions, five levels of protection were ultimately designated for each beneficial end use. These levels of protection, the water quality parameters, the degree of water quality control and example remedial and mitigating measures are given in Tables 1 to 3. Their development is discussed in more depth in Document 2.

TABLE 1: LEVELS OF PROTECTION FOR CONTACT AND NON-CONTACT RECREATION

Degree of Protection	WQ Parameters of Concern	Level of Water Quality Control	Control Options or Further Studies Required to Achieve Degree of Protection
1. Status Quo - Incidental contact with water produces skin rashes etc. but no direct, known human diseases.	o Fecal coliforms	o Existing WQ in river with no further decline to development. o No increase in loadings to lake.	o Control FC discharges with ponds in new developments to less than 100 FC/100 mL, 90% of the time. This may involve full capture of small events; and disinfection of overflow in each pond by U.V.
2. Limited Aesthetic and Water Quality Improvement - Incidental contact produces no skin rashes nor known human diseases. - Non body contact recreation. - Increase compliance with RAP.	o Fecal Coliform	o Improvement in colour and turbidity. o Minimize discharges of rash causing substances. o 10% decrease in FC discharges to lake.	o Carry out studies to evaluate the risk of non-contact recreation. o Ponds or infiltration trenches in new developments. o Control 50% of CSO discharges. o Ponds or infiltration trenches in redevelopment (e.g. St. Lawrence Square).
3. Substantial WQ Improvement A. Incidental swallowing of water during non body contact recreation in river. (e.g. wind surfing, canoeing) B. Body contact recreation in reservoirs and ponds. C. Partial compliance with RAP.	o Fecal Coliforms	o Decrease FC levels in river by 50%. o Meet quality standards in reservoirs for all conditions except after 10 mm rainfall and greater. o 50% decrease in FC discharge to lake.	o Carry out studies to evaluate the risk from incidental swallowing of river water. o Control 90% of CSO discharges. o Reduce bacti discharges from 25% of storm o sewers o apply above options for industrial, new and redevelopment.
4. Body Contact Recreation A. Reservoirs - short term and long term B. River - dry weather periods C. Lake - meet RAP objectives	o Fecal Coliforms o Pseudomonas Aeurginosa **OR**	o Meet quality standards in reservoir swimming areas 90-95% of the time. o Meet quality standards in river 48 hr. after rain storm. o Decrease FC discharge to L. Ontario by 90%. o Meet RAP objectives for Island Beaches (this may involve a discharge of 3000-5000 FC/100 mL at mouth of Don River).	o Determine which of the WQ control levels is limiting. o Disinfection of discharges from new developments and reservoirs. o CSO discharges limited to 1-5% of time. o Control bacti discharges from 50% of storm sewers. o Establish appropriate RAP objectives; change 90% as necessary.
5. Body Contact Recreation At All Times A. Meet standards in river - Everywhere - All the time B. Meet RAP Objective	o Fecal Coliform o E. coli o Pseudomonas Aeurginosa	o Meet quality standards for all conditions except certain small fraction (e.g. 5%).	o Control of all CSO's. o Control of all storm sewers.

TABLE 2: LEVELS OF PROTECTION FOR FISHERY ENDUSE

Degree of Protection	WQ and HSI Parameters of Concern	Level of WQ and Fishery Control	Control Options or Further Studies Required to Achieve Degree of Protection
1. Status Quo	o Aesthetic Parameters o DO o TP o SS o Metals	o Existing WQ without further decline due to development.	o No infilling of intermittent order 1 streams and order 1 streams to provide food source for downstream fishery. o Protection of existing red side dace habitat and MNR maple hatchery areas. o Wet ponds in new development.
2. Limited WQ, Fishery and Aesthetic Improvement	o Aesthetics - lumps - colour - smell o Conventional WQ parameters o TP o BOD	o No transmittable diseases in fish. o Continue present BOD control. o Reduce TP 20%. o No visible solids/lumps/debris/scum. o No significant smell. o Reduce.	o Improve spills control. o Minimize frequency of CSO's discharges. o Reduce TP discharges through ponds or other devices. o Enhance canopy cover in upper and middle watershed.
3. Urban Sports Fishery in Upper River, Reservoirs and Ponds	o Fish Habitat - physical . Q, temp. . rubble; pool riffle o Chemical - Metals: Cu, Zn, Hg - Organics - PCB's - DO, pH - TRC, NH_3	o No fish tainting. o Adequate bottom habitat for internal migration. o Meet HSI parameter levels. o Non toxic water in relevant water bodies. o Adequate food sources. o Meet fish consumption guidelines for smallmouth bass most of the time.	o No spills in upper watershed. o Control of 90% of CSO discharges. o Rubble, pool/riffle habitat throughout upper watershed. o Removal of all concrete channels. o HSI study to define other needs. o Enhance canopy cover over 75% of watershed.
4. Warm Water Fishery Throughout Don River	o Fish Habitat - physical . Q, temp. . rubble; pool riffle o Chemical - Metals: Cu, Zn, Hg - Organics - PCB's - DO, pH - PRC, NH_3	o Same as 3 above throughout Don River. o Meet PWQO's for warm water fishery for protection of aquatic life. o Non-toxic water throughout watershed. o Meet fish consumption guidelines for smallmouth bass.	o No spills throughout watershed except 5%. o CSO removal from watershed. o Appropriate bottom habitat throughout the whole river. o HSI study to define other needs. o Enhance canopy cover over whole watershed.
5. Migrating and Warm Water and Hatchery Maintained Cold Water Fishery	o Same as 3 above	o Same as 3 above for warm water fishery. o Meet PWQO's. o Temperature less than 22°C at all times in major pools of river reaches containing a cold water fishery o Reduce sublethal toxic.	o Same as 4 above, plus o Canopy cover along all order 2 and 3 streams (including channelized and storm sewered areas).

TABLE 3: LEVELS OF PROTECTION FOR AESTHETICS

Degree of Protection	WQ and Other Parameters of Concern	Level of Water Quality and Landscape Architecture Control	Control Options or Further Studies Required to Achieve Degree of Protection
1. Status Quo	o Riverine aesthetic parameters - colour during dry weather - spills and event related colour - turbidity o Valley aesthetics - vegetative cover - cleanliness - decrease of debris	o Existing WQ without further decline due to new development.	o Develop plan involving landscape, vegetation, land-based biota, ESA's, and any marshes. o Establish aesthetic standards required for level 5.
2. Limited WQ and Aesthetic Improvements	o Riverine aesthetic parameters - colour during dry weather - spills and event related colour - turbidity o Valley aesthetics - vegetative cover - cleanliness - decrease of debris	o No visible solids/lumps/debris/scum. o No significant smells. o Partial improvement of valley aesthetics. o Decrease slimes and other growths. o Limited canopy improvement.	o Improve spills control o Minimize frequency of CSO discharges. o Reduce TP discharges through ponds or other devices. o Decrease TP discharge from STP by 50%.
3. Significant Improvement in Aesthetics of River and Water and Valley	o Riverine aesthetic parameters - colour during dry weather - spills and event related colour - turbidity o Valley aesthetics - vegetative cover - cleanliness - decrease of debris	o Reduce SS discharges from all construction. o Reduce SS discharges by 50% for storms of 5 mm and smaller. o Eliminate 50% of slimes. o Establish required canopy in 50% of valley system.	o No spills in upper East/West Don; spills control in Lower Don. o Control 90% of CSO discharges. o Reduce TP discharges from 25% of storm sewers. o Vegetation, setbacks, and shoreline enhancements.
4. Valley Aesthetics Acceptable, Periodic Problems With Aquatic Aesthetics	o Riverine aesthetic parameters - colour during dry weather - spills and event related colour - turbidity o Valley aesthetics - vegetative cover - cleanliness - decrease of debris	o Reduce SS discharges by 90% for storms of 10 mm and smaller. o Reduce slimes by 90%. o Improve water colour from grey colour. o Establish required canopy in all of valley system.	o Spills throughout watershed minimized to 1-5% of current levels. o CSO discharges minimized to a few events/year; partial treatment of these overflows o Reduce TP discharges from 50% of storm sewers o Complete vegetation installation, recreation development.
5. Aesthetically Acceptable by All Conventional Standards	o Riverine aesthetic parameters - colour during dry weather - spills and event related colour - turbidity o Valley aesthetics - vegetative cover - cleanliness - decrease of debris	o Control of all SS, colour, spills. o Improve valley canopy as per level 4.	o Improved spills control above level 4. o Minimize CSO discharges to one overflow/year, partial treatment of that overflow. o Reduce TP, discharges from all storm sewers by 90%. o Reduce SS solids discharge by 80-90% for all storms smaller than 20 mm by sizing ponds on all stormwater outlets. o Control of all sources.

Existing conditions (or status quo) is shown as the lowest level of water quality based on:

- o instream water quality samples,
- o assessment of the frequency of spills and general aesthetics during both dry and wet weather conditions, and
- o estimation of instream concentrations for the April to October, 1984 period.

Status quo requires active water quality management to ensure that no further degradation occurs with new developments in headwater areas. As is inferred by the above table, each alternative level infers a higher degree of water quality which is more difficult to achieve and which has a higher cost associated with it.

1.10 Remedial and Mitigating Measures Considered

In order to establish the feasibility and cost to meet each level of water quality, several mitigating options were considered. The various types of options were grouped and may be summarized as follows.

Option Number	Mitigating Option	Description
1	North Toronto STP Upgrade	o chemical/biological upgrade for phosphorus and nitrogen control.
2	North Toronto STP Removal	o discontinuation North Toronto STP; effluent and bypasses would be rerouted to Main STP.
3	Combined Sewer Overflow Control	o storing of combined sewer overflows, flows would be rerouted to Main STP.

Option Number	Mitigating Option	Description
4	Urban Retention Ponds	o construction of instream or offline wet ponds to capture pollutants from urban runoff.
5	Urban and Rural Maintenance	o catchbasin cleaning, street sweeping, litter control bylaws.
6	Urban & Rural Best Management Practices	o on-site water control, grassed swales, wetlands, riparian vegetated zones.
7	Flow Reduction Through Redevelopment or (Infiltration of Surface Water into Groundwater)	o infiltration trenches, groundwater recharge systems, porous bottom catchbasins, porous pavement, soakaway pits.
8	Option 4 and Option 7	
9	Options (3-7) With STP Removal	
10	Options 4 and 6 for Future Development	o revising or updating existing stormwater management practices.
11	Spill Control Programs	o implementation of Comprehensive Spills Management and Mitigative Program.
12	Erosion Control Programs	o bank stabilization, provision of buffer strips, sediment control measures during construction.
13	Sewer Use Bylaw Enforcement	o monitoring programs to check for cross connections between the sanitary and storm sewer systems.

Option Number	Mitigating Option	Description
14	Agricultural Controls	o crop management, manure storage and handling control.
15	Fishery Enhancement	o improvement of physical habitat for fisheries.
16	Snow Dumps	o location/runoff control.
17	Management of Chemical Usage	o control of fertilizer and pesticide use.
18	Public Education	o control of fertilizer and pesticide use and disposal of household hazardous waste

For this study, the benefits of implementing options 1 through 10 were dealt with in a quantitative sense, while the benefits of the remaining options were considered in a qualitative manner. Option 7 deals with the redevelopment of lands and includes extensive measures to improve water quality in the long term (50-100 years). As will be discussed later, this option could have considerable impact on water quality and may well be necessary if several of the PWQO's are to be attained on a continuous basis. Option 10 considers the implementation of Best Management Practices and the construction of retention (wet) ponds on a watershed wide basis. Several of the municipalities are currently implementing these options.

2. Quantitative Evaluation of Control Options

A simplified spreadsheet analysis was carried out to:

- o establish instream concentrations for suspended solids, total phosphorus, ammonia, copper, lead and fecal coliforms at the four representative locations; and

- o estimate the effectiveness of various mitigative options in reducing concentrations and loadings of the above-noted parameters.

A loading-dilution model was mandated by the terms of reference of this study to evaluate effectiveness of remediation. The basis of this model is given in Supporting Document 1. The model estimates loadings from all sources, their reduction due to remedial measures, and the concentration as the net loading divided by the stream flow rate. All substances are treated as conservative over a suitable time frame except for bacteria which decay in the stream. The methodology was used to evaluate seasonal conditions as well as dry weather and specific sized rainfall events.

Both flow and loading components of the model were calibrated to observed flows and concentrations. This gives confidence in its calculations on a seasonal basis, but it is less precise for specific events due to source loading conditions and instream loadings.

The results have been summarized in Document 1. Representative findings are attached here in Appendix 1. In all cases, a range of concentrations has been given to reflect the varying input loadings from the different pollutant sources.

Four typical conditions have been summarized, these being dry weather conditions and conditions for a 5, 10 and 20 mm rainfall event. Dry weather conditions occur a majority of the time (about 70%). On days when precipitation does occur, the cumulative daily rainfall volume is less than 5 mm about 50% of the time. Precipitation patterns within the Toronto area also show that the likelihood of precipitation on a given day exceeding 10 mm or 20 mm is 7% or 2%, respectively. Thus, the four conditions reflect the dominant scenario (dry weather), average wet weather conditions (5 mm) and two less frequent conditions (10 mm, 20 mm).

In general, the results of the analysis show that:

- the concentrations are lowest in the upper Don River and increase downstream; this may be attributed to the fact that the upstream land uses are a mixture of rural and urban, while the lower catchments are fully developed; furthermore, the North Toronto STP and combined sewer overflows discharge flows in the lower reach;

- the concentrations, for a given condition, increase by a factor of 1 to 3-fold, from the upstream to middle reach and by an additional 1 to 10-fold from the mid to lower reach; Massey Creek, a heavily urbanized catchment with combined sewer overflows and industrial areas has concentrations of approximately 2 to 10-fold higher than the upper Don which is the least developed watershed.

- the concentrations are lowest for dry weather conditions and increase by a factor of 1 to 30 for wet weather conditions;

- much of the river system may be stressful to aquatic life due to elevated levels of ammonia, copper and zinc, but the lower Don, during either dry or wet weather conditions, is the only stretch of river to have substantive levels of these and other (e.g., total residual chlorine) potentially toxic substances.

- pollutant loadings within the upper and middle reaches during dry weather conditions are primarily attributable to urban sources (infiltration/inflow into storm sewers, cross-connections between sanitary and storm sewers); in the lower reach, the urban sources and North Toronto STP are both significant pollutant sources; and

- the dominant source of pollutant loadings for wet weather events are the discharges from storm sewers; combined sewer overflows are only a significant source for fecal coliforms and are only present in the lower reach; the North Toronto STP, during wet weather conditions, is a source of total phosphorus and ammonia in the lower Don.

The results may also be used to compare instream concentrations to target values (see Table 4). For this study, target values are defined as concentrations which would, from a water quality perspective, support specified beneficial uses. The findings show that, on average:

- suspended solids concentrations are well below the target value for dry weather conditions at all locations and are in the range of the target value for wet weather conditions; the target value (200 mg/L) which reflects a fishery end use, is far from an aesthetic end use (5-10 mg/L);

- total phosphorus concentrations during dry weather conditions are highest in the lower Don due to the STP (4 times target value); the concentrations in the upstream reach are in the vicinity of the target value during dry weather conditions. For wet weather conditions, the concentrations exceed the target value by 2-fold in the upper reach and by 4-fold in the lower reach;

- ammonia concentrations are well below target values for all of the river system except in the lower reach of the Don River. There, the concentrations approach but are still below target values during wet and dry weather conditions;

- copper concentrations, during dry weather conditions, are also in the vicinity of the target value in the upstream reach; the concentrations in the lower Don increase by a factor of five. During wet weather, the exceedances vary from a factor of 3 to 6 for the upper and lower Don reaches, respectively;

- lead concentrations are generally below, or in the vicinity of the target value for dry weather conditions; for wet weather, the concentrations are about twice the level at the downstream reach as compared to values in the upstream reach; furthermore, they exceed the target value by 2- to 5-fold in the upper and lower reaches respectively;

- fecal coliform concentrations always exceed the target value by a considerable amount; the exceedances range from approximately ten-fold for dry weather (upper Don) to 250-fold for wet weather in the lower reach; Massey Creek wet weather concentrations are higher than the Don River concentrations due to the combined sewer overflow loadings.

TABLE 4: COMPARISON OF VALUES ASSESSED IN THIS STUDY AND PWQO'S

Parameter	PWQO	Assessed Value
Total Phosphorus	30 ug/L	100 ug/L*
Fecal Coliforms	100 FC/100 mL	100 FC/100 mL
Copper	5 ug/L	5 ug/L
Lead	25 ug/L	25 ug/L
Ammonia (unionized)	20 ug/L	20 ug/L
Suspended Solids	-	200 mg/L (fisheries related) 5-10 mg/L (aesthetics related)

*Based upon U.S. EPA values which are 30 ug/L, 50 ug/L, and 100 ug/L for different degrees of nuisance algal growth, aesthetic deteriorations, and/or excessive plant growth. 100 ug/L was selected as an interim value for this study because most major rivers in Southern Ontario have phosphorus concentrations routinely in the 100 ug/L range.

Based on the above findings and desired levels of water quality as outlined previously, several mitigating options were analyzed to determine whether individual options or groups of options are required to approach or attain the target values. The findings could then be used as a basis to formulate a recommended strategy for improving the water quality within the Don River. The final strategy would also consider the findings of other components of the study (i.e., spills control, habitat suitability), and would consider factors such as cost, implementability, safety and maintenance.

The mitigative options that were considered are outlined below. A considerable amount of effort was put into evaluating mitigative options which would reduce pollutant loads from the storm sewer systems, as the above analysis showed that this source produced a majority of the pollutant loadings:

1. North Toronto STP upgrade,
2. North Toronto STP removal,
3. combined sewer overflow removal,
4. urban in-line or off-line ponds,
5. urban and rural wet and dry maintenance practices,
6. urban and rural wet and dry vegetated Best Management Practices,
7. flow reduction through redevelopment,
8. off line ponds and flow reduction through redevelopment;
9. Items 2 through 7 inclusive.

The reduction in instream concentrations for the above scenarios is given in Appendix A.

Briefly stated, the findings showed that:

Wet Weather Conditions

- urban wet ponds and flow reduction through redevelopment are the most effective options for reducing the concentrations of all parameters. Collectively, implementing both options would reduce the concentrations during most rainfall events to values approaching the target value for suspended solids, total phosphorus, copper and lead;

- upgrading or removing the STP or eliminating combined sewer overflows are not as effective as the above options on a watershed scale; and
- fecal coliform values are improved, but additional control is required to achieve target values.

Dry Weather Conditions

- the construction of wet ponds or implementation of flow techniques would likely be beneficial in reducing concentrations of most parameters in the upper and mid reaches. However, the effectiveness of these options to reduce instream concentrations during dry weather conditions has not been well documented. Furthermore, the simplified approach used in this study does not consider the secondary mechanisms (such as settling of fine particles during quiescent conditions) which would result in a reduction of concentrations. As such, the Tables in Appendix A indicate that concentrations during dry weather conditions are insensitive to the control options.

- upgrading or the removal of the North Toronto STP is effective in reducing total phosphorus ammonia, copper and lead within the lower reach.

To achieve fecal coliform target values (100/100 mL) for either dry or wet weather conditions, additional control other than the above options is required. This would take the form of additional storage (residence time of longer than 4 days) or disinfection of pond overflows. Based upon the potential aquatic toxicity resulting from disinfection with chlorine (Supporting Document 2), disinfection with U-V light or ozonation is preferred. The latter two technologies are evolving and at this time are unproven within the confines of a stormwater management facility.

Based, in part, on the above findings and other qualitative assessments, a recommended strategy for improving the instream water quality has been developed. The strategy is meant to provide direction in an attempt to define which beneficial water uses can be attained, which mitigating options are required, and what sequence should the options be constructed.

Ultimately, the principal uses which could be met include:

- improvement in water quality aesthetics;
- re-establishment of a warm water fishery;
- substantial reduction in pollutant loading to Lake Ontario; and
- significant improvement in swimming conditions in the river, and in beaches influenced by discharges from the Don River.

As was discussed previously, the feasibility of attaining non-contact or contact recreational activities within the Don River would be dependent upon additional options such as extended storage time or disinfection. The feasibility of these alternatives is uncertain at this time.

3. Qualitative Evaluation of Additional Control Options

3.1 Options Evaluated

Several sources of pollutants within the Don River watershed were evaluated in a qualitative sense. These include:

- o old industrial establishments connected to storm sewers;
- o construction activity;
- o agricultural and rual land activities;
- o stream bank and overland erosion;
- o groundwater leachate from dumps and old landfills;
- o presently used leachate collection and treatment systems used at the Maple landfill site;
- o atmosphere deposition;
- o spills; and
- o application of herbicides, pesticides and fertilizers to buildings and soils.

A summary of the major contaminants from these sources are given in Appendix 2 of Supporting Document 1.

Perceptual and literature values for pathways and monitoring data in the River were used to evaluate their potential importance to this study. An indepth analysis of spills was carried out in consultation with the various municipalities.

3.2 Spills Remediation

In the spills component of the study, estimates of the frequency, type and magnitude of spills were obtained and possibilities for improvement in spills management programs were evaluated. An assessment was made of the possibilities of estimating loads to the river from spills. In addition, an assessment of the impact of spills upon aquatic biota was used to compare spills to CSO's and stormwater runoff. The major results of this study point toward such recommendations as:

i) enhance existing spills control programs;

ii) education of the first personnel upon the scene of a spill to use techniques to contain spills where possible, rather than to dilute and wash them down the nearest sewer; and

iii) structural controls should be placed on stormwater/CSO discharges which are particularly susceptible to spills activity.

3.3 Other Water Quality Attributes

3.3.1 Response of Aquatic Toxicity and Fisheries Habitat

In addition to the response of riverine chemical concentrations to control, the potential toxicity of the riverine water, and the response of the fishery to control were evaluated. The major effort consisted of evaluating the response of the fishery and riverine toxicity together using a Habitat Suitability Index (HSI) Model.

The HSI model evaluates the suitability of physical conditions (bottom rubble, flow rate, velocity, stream depth, temperature) and chemical conditions (pH, dissolved oxygen) to a fishery. For this study, a toxicity component was incorporated into the HSI model to allow evaluation of the main factors limiting the existance of a quality fishery.

Meetings were held with various technical specialists to develop hypotheses of limiting factors and to evaluate the potential response of the fishery to water quality management. Smallmouth bass was chosen as a target species for use in the HSI model because it is an indicator of a quality ecosystem and is a potential index of the reestablishment of a fishery. Analysis of the HSI model application suggest that at least six factors may limit the reestablishment of a quality warm water fishery.

i) inhibitory effects of certain chemical constituents (metals, ammonia, residual chlorine),

ii) spills and CSO's in particular reaches;

iii) food sources for the fish;

iv) bottom habitat in certain reaches;

v) restoration of appropriate canopy; and

vi) management of human fishing activity.

Of other factors considered, dissolved oxygen concentrations appear to be adequate at all times, except for sites where detailed monitoring data are not available (e.g., within 10-20 cm of aerobic sediments in the lower river). Also, the stream gradients and upstream fish food sources appear to be much better than perceptual evidence suggested. However, these upstream fish food sources need to be maintained if urban development occurs in headwater areas. The role of intermittent, first order streams in the ecology of a quality fishery requires further assessment.

Neither flow, temperature nor turbidity appear to be as important as these "six" variables to the warm water fishery. However, temperature is the key variable for cold water species for maintaining the limited cold water habitat in the headwater reaches, or if the Ministry of Natural Resources were to establish an objective of a cold water fishery for the lower river.

These factors suggest the need for various management actions. These include:

i) maintaining and enhancing headwater streams in their present state;
ii) development of a non-toxic river, particularly in the Lower Don River;
iii) development of protocols to assess the toxicity of present waters to a matrix of target organisms such as Daphnia, smallmouth bass and rainbow trout;
iv) control of spills and CSO's;
v) development of riparian vegetation to moderate temperature variations and enhance the food chain for the fishery; and
vi) development of a comprehensive fish management plan.

3.3.2 Organic and Industrial Chemicals

Organic and industrial chemicals originate from a variety of sources including industrial chemicals, petroleum products and herbicides and pesticides. Pesticides such as lindane and methoxychlor have been identified in the main branch or tributaries such as Sunnybrooke Creek. Monitoring data are available for a variety of these chemicals. The data base suggests that a decrease in reactive phenolics has occurred over the past decade but the database for most other organic chemicals are too short to show trends. The data base requires new modelling efforts and quantification of loadings from various sources to develop estimates of the response of river concentration to control efforts.

Efforts to limit releases of organic chemicals to receiving waters are required. Source control would appear to be the most effective method due to the trace levels found in receiving water and the myriad of sources. However, it will be quite difficult to audit the effectiveness of source control due to several factors including lack of data describing usage patterns, the difficulty of ensuring good housekeeping practices, changes over time in the types of chemicals which are used (e.g., replacement of one herbicide with another), and the time for organics to move from the site of usage to the receiving water.

Recommendations presented below are oriented towards:

- obtaining data to confirm usage rates in the watershed;
- education of industrial users and householders of source control and handling practices; and
- enhancing current municipal waste collection programs to gather and dispose waste chemicals.

4. Recommended Strategy

Existing water quality suggests that the water quality of the Don River is considerably degraded with the primary source of pollution being urban runoff. In order to improve the water quality and achieve the beneficial uses as described previously, the following remedial and mitigating measures should be considered:

- construction of wet ponds in existing urban areas on a watershed wide basis;
- improvement of on site water quality through redevelopment (in essence, the same quantity of runoff in urban areas would be infiltrated into the ground as occurred prior to development; this would be attained through the construction of infiltration trenches, recharge basins, porous pavement, soakaway pits, etc.);
- continuation or extension of programs to detect cross-connections between the sanitary and storm sewer systems;
- implementation of comprehensive spill control and management programs;
- rigorous enforcement of erosion and sedimentation control practices as outlined in "Guidelines on Erosion and Sediment Control for Urban Construction Sites";
- construction of wet ponds to service new developments (presently a majority of the ponds are dry) and implementation of Best Management Practices for these areas;
- improvement of the physical habitat to promote a better fisheries;
- promotion of public education programs, i.e., litter control, poop and scoop;
- elimination of channelization works within new developments in cases where existing fisheries may be endangered;
- installation of control devices to trap floatable oil films, debris, etc. from all combined sewer overflows and storm sewer outfalls;
- construction of natural channels (i.e., meandering to low flow channels, creation of pools and riffles, selective use of impermeable materials) for reconstruction of existing watercourses;
- installation of riparian habitat along river courses;
- pilot projects to develop a warm-water urban sports fishery; and
- a comprehensive fisheries and ecosystem-based watershed management plan (including flood control, erosion control; terrestrial wildlife and water fowl).

These measures will effect substantive improvements in all parameters. To approach targets for swimming, disinfection or extended storage of most stormwater discharges are required.

Several new innovative measures are described above. Three measures are illustrated in the accompanying photographs as follows:

i) various types of wet ponds and the potential recreational uses (Figures 2 through 5);
ii) a perforated underground recharge facility for a residential development (Figure 6); and
iii) an example of groundwater recharge via an infiltration trench for a commercial/industrial development (Figure 7).

For CSO's, recommended strategies are particularly oriented toward mitigative measures which improve aesthetics (i.e., removal of debris, floatables, etc.). The reasons for this recommendation are given below.

Combined sewer overflows may be of concern for several reasons including aesthetic considerations, spill control, fisheries or bacterial loading and the associated impact on contact recreation, both within the Don River and nearby beaches (especially the Centre Island beach).

The CSO's within the Don River are all located near the downstream limit of the watercourse. The results of the analyses suggest that CSO's contribute significant loadings only for fecal coliforms.

The study limits for this study were defined as the Keating Channel and the headwaters. However, previous work indicates that under certain conditions (i.e., specific wind directions and thermal gradients), the loadings from the Don River may impact the Centre Island beach (pers. comm., Dr. M.D. Palmer). A value of 4,000 FC/100 mL was established in previous studies as the upper limit of the fecal coliform densities from the mouth of the Don River, if the Centre Island beach is <u>not</u> to be impacted by Don River discharges. The results of this analysis and previous work would suggest that substantial reduction in both CSO and storm sewer loadings would be required to attain this value.

Figure 2 - Rural Type Pond
Maple District - Ministry of Natural Resources, Maple, Ontario

Figure 3 - Urban Type Facility - Vancouver

Figure 4 - Twogood Pond - Unionville, Ontario

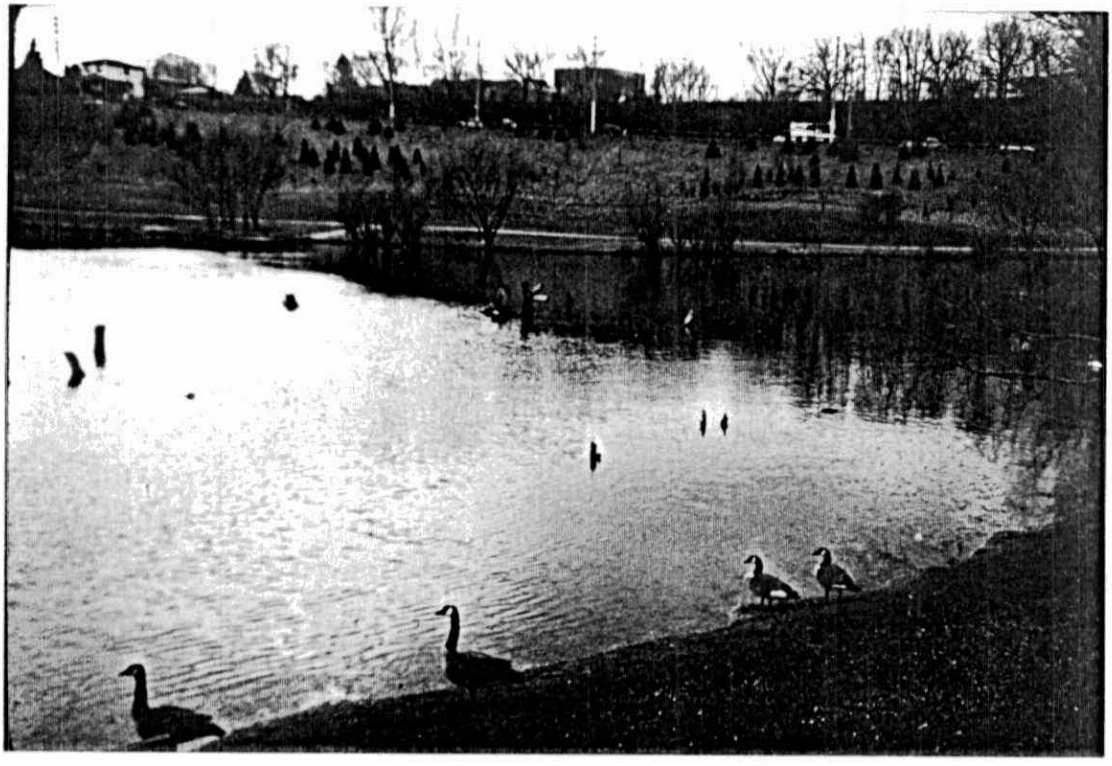


Figure 5 - Natural Type Setting
Eglinton Avenue - Jane Street - Toronto, Ontario

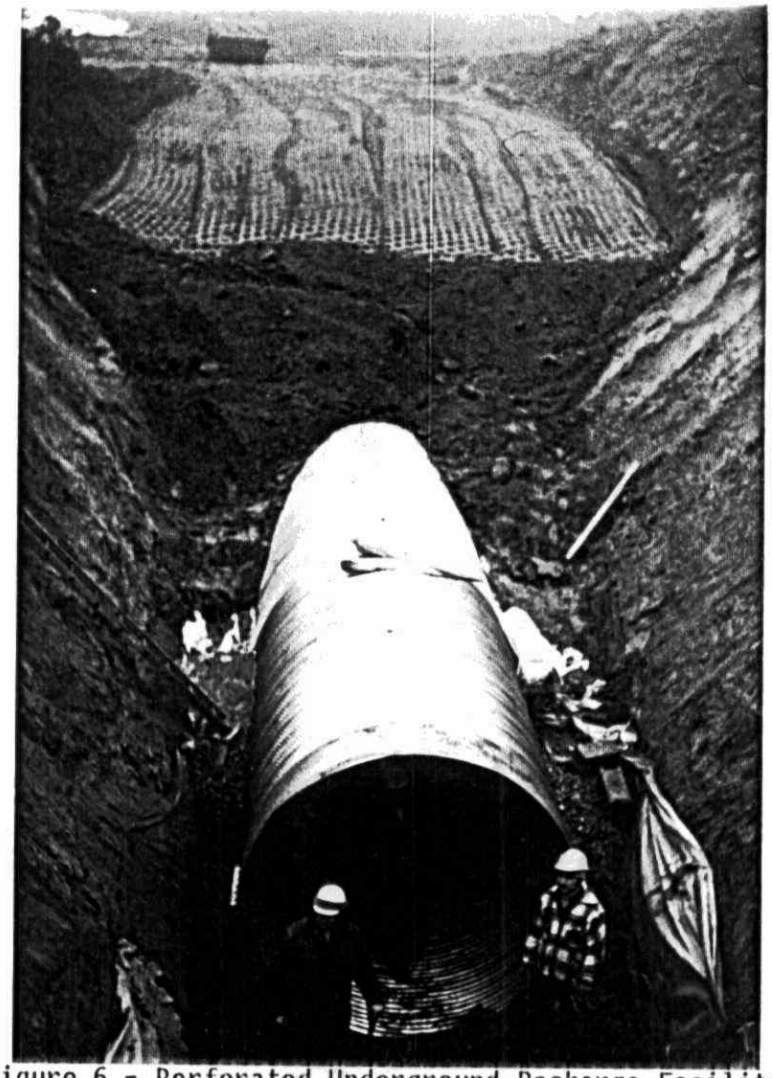


Figure 6 - Perforated Underground Recharge Facility
Brampton, Ontario

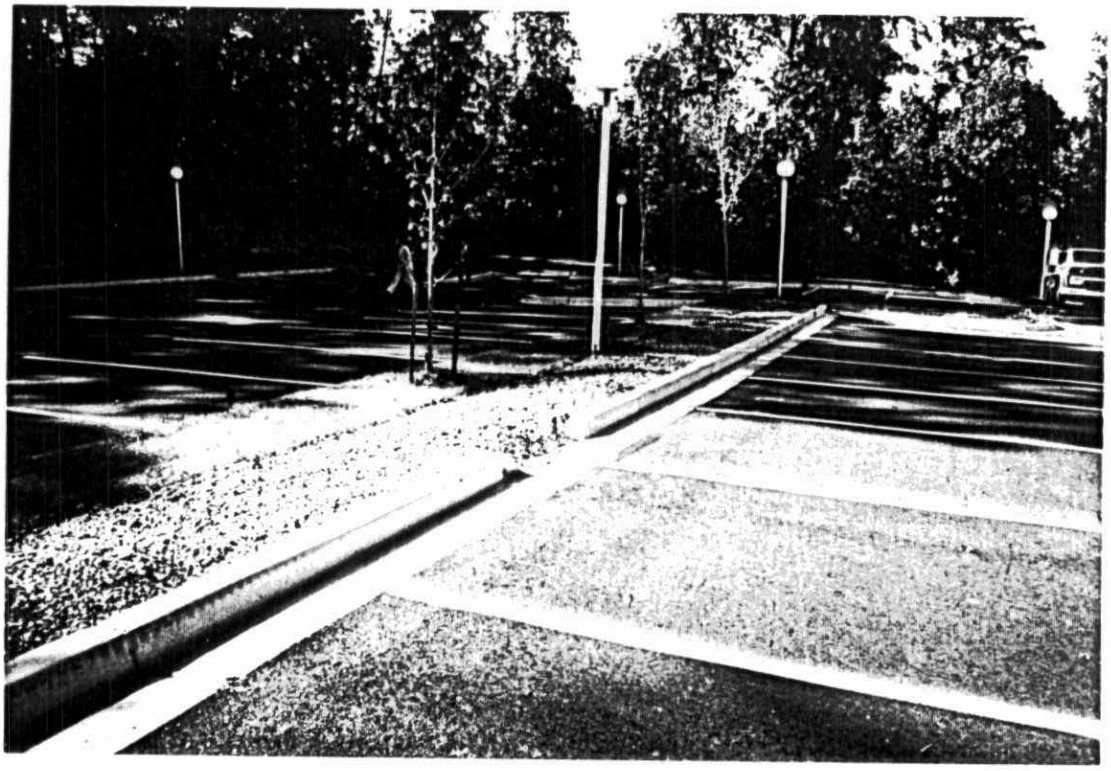


Figure 7 - Groundwater Recharge Via Infiltration Trench
Maryland, USA

Furthermore, results from this study show that for a majority of rainfall events, a substantial reduction in CSO loadings (90 percent removal) would still result in fecal coliform densities at the mouth exceeding 4,000 FC/100 mL.

A separate, more detailed study is being carried out to determine the feasibility and cost to store and treat CSO's at the Main STP.

Based on the above points it would seem that further study is required to determine the cost-effectiveness of storing and/or treating CSO's. As such, the recommendation for minimizing the impact of CSO's would be to construct works which would improve aesthetics due to the capturing of floatables and debris.

A suggested strategy is now presented in three phases. The strategy as presented would result in the maximum beneficial uses being attained. Implementation of several of the options would result in attaining levels of protection for the beneficial end uses as outlined in Tables 1 to 3.

In addition, removal or upgrading of the North Toronto STP should be strongly considered. This recommendation is based on the findings within this study which show that the STP does contribute significant copper, lead and ammonia loadings in dry weather, within the lower Don, and that it is a factor in the potentially toxic conditions that occur within this stretch of the river. However, a detailed study is currently being carried out which will address the feasibility and cost of conveying North Toronto STP flows to the Main STP. Furthermore, the impact of modifying the use of the North Toronto STP should be viewed from a Metro Toronto wide perspective (impacts upon sewer systems, other STP's) and from a receiving water perspective of river system, impact on baseflow and fisheries, and nearshore lake sections. Until these considerations are completely evaluated, a final decision on this matter cannot be made.

The recommended strategy is all encompassing in that it considers:

- existing programs for improving water quality;
- options for improving, in the short-term, the water quality from existing development areas;

- o recommendations for minimizing the impact of future development in the headwaters of the watershed; and
- o a framework to improve water quality in the long-term as redevelopment occurs.

The proposed works as recommended in this study have been constructed or implemented in other areas and have proven to be effective. However, the feasibility of implementing all options (for example, the feasibility of acquiring the land to provide a suitable location for the proposed wet ponds) has not been established. Furthermore, other considerations such as public and municipal acceptance and ease of implementation have to be accounted for.

The first two phases attempt to include those mitigating options which are readily implementable and quite cost-effective. The third phase includes those measures which are required to achieve significant water quality improvements over the long term but which are more costly and less readily implementable. The suggested strategy also reflects the implicit philosophy that treatment of all sources by structural and non-structural methods will ultimately be required to attain the beneficial end uses of a quality fishery contained in a non-toxic, swimmable water.

To treat runoff from areas which are already developed, roughly 200 wet ponds would be required. The facilities, on average, would drain an area of about 1.2 km^2 and would have a surface area of approximately 6 ha (similar in size to the facilities shown in Figures 2 through 5). The surface area of each facility would be between 0.2 to 0.5 percent of the drainage area. On average, each facility would service 6 to 8 sewersheds (there are approximately 1400 outfalls).

Flow reduction techniques include infiltration trenches (Figure 6), groundwater recharge systems (Figure 7), porous bottom catchbasins, porous pavement and soakway pits.

The suggested phasing is as follows.

4.1 Immediate Actions (1989-1990)

1. A variety of aesthetic improvements be undertaken, including:

   - o stream clean-up;
   - o deposition of brush bundles and construction of emergent/submergent marsh grass stands in designated areas for fish habitat; and
   - o signage (to increase public awareness of improvement efforts).

2. Demonstration projects should be implemented for the following:

   - o natural channel design (to incorporate fish habitats and stream bank vegetation into a new upstream channelization project);
   - o urban fishing in a Don River triburary; and
   - o disinfection or extended storage of a wet pond to achieve swimming objectives.

3. Results of wet pond demonstration projects from other watersheds and monitoring from other studies should be developed into a manual for implementation of wet ponds.

4. Off-line, wet ponds be constructed immediately in areas where new development is planned. Urban Best Management Practices should also be implemented. Furthermore, design considerations should be given for the provision of bacterial control.

5. Flow reduction be implemented where soil conditions are appropriate in all new developments.

6. Interim stormwater quality guidelines be evaluated for adoption by municipalities for new developments and for areas undergoing redevelopment.

7. All present stormwater management facilities in the Don River watershed should documented and assessed as to their potential ease of conversion to wet ponds or to extended detention ponds.

8. Priority sites for control of bacterial discharges from existing sources (storm sewers, CSO's) should be established.

9. Existing studies be synthesized into useful criteria for design and approval of wet ponds. Such criteria should incorporate, where feasible, water quality control; water quantity control; aesthetic, social, and landscape amenities; erosion control; internal water quality (eutrophication, fecal coliforms) considerations; fisheries habitat and wildlife habitat. Site specific attributes will require prioritizing these criteria.

10. Implementation of this study's recommendations should be established after consideration of cost-effectiveness, environmental impact, public and municipal acceptability, legal feasibility, etc.

11. Rigid enforcement of erosion and sediment control guidelines during construction must be achieved immediately.

12. The role of intermittent, order 1 headwater streams as a food supply for the downstream fishery should be studied and the appropriate degree of protection established.

13. A variety of vegetated and other BMP's be implemented in publically-owned, valley lands including:

    - o a riparian habitat program along all stream banks with priority given to eroding stream banks in the headwater areas and the open valley; and
    - o the Charles Sauriol Conservation Reserve on the East Don (Lawrence Avenue South to confluence with West Don).

4.2 Phase 1 (5-10 Year Time Frame)

1. The practice of constructing off-line, wet ponds and urban BMP's, began under the immediate phase, should be continued. These performance of these facilities should be audited.

2. Off-line ponds be constructed within existing built up areas. Initially, ponds should be constructed in areas where land may be available or where large drainage areas containing old developments exist.

3. Riparian habitat, canopy restoration, natural channel designs and control of substances which contaminate fish flesh should be implemented.

4. An inventory of the rate of usage of fertilizer, solvents, residential and agricultural herbicides, pesticides, and fungicides in the watershed should be made. Education and other programs for decreasing their rate of usage and improving handling practices should be implemented.

5. The remedial programs already in existance (listed under Phase 2, Point 7) should be audited to assess their impact on water quality and changed as required to achieve water quality objectives.

6. Existing programs to detect cross connections between the sanitary and storm sewer systems should be continued.

7. Flow reduction alternatives should be implemented for commercial/industrial areas as they redevelop.

8. Existing source control programs should be audited, prioritized, and improved. Programs to construct spill containment facilities on each storm sewer outlet should be implemented and audited. Priority for construction of spills control facilities should be directed towards highly susceptible areas.

9. Education of spills control personnel are required. Development, enhancement, coordination, and implementation of comprehensive spills control programs are required, dependent upon political jurisdiction.

10. Adequate personnel should be employed to ensure rigid enforcement of erosion and sedimentation control guidelines during construction.

11. The results of this study indicate that additional information is required to address the following water quality issues:

- o the capabilities and limitations of currently used predictive tools;
- o inadequacies in the data base for relating causes of pollution to concentrations observed in the river for such substances as synthetic organic chemicals;
- o the impacts of storm water infiltration upon groundwater quality;
- o the impact of landfill leachate upon groundwater and surface water quality;
- o the present toxicity of riverine water and sediment; and
- o the methods required to control in-place pollutants and to rehabilitate the river bottom.

This additional information may be generated by future studies undertaken on the watersheds. The findings from these studies should be reviewed and applied as appropriate to the Don River.

12. The need for additional stormwater treatment than is presently offered by wet ponds (e.g., physical-chemical treatment technologies) should be evaluated.

13. Comprehensive Basin Management planning for the Don River should be continued which:

- o relates Water Quality Management in the Don River to the Ecosystem Based Principles which have been developed by the International Joint Commission for Great Lakes Water Quality;
- o evaluates the effectiveness of controls and selects the most appropriate strategy for improvements;
- o incorporates all relevant water management concerns (water quality, flood control, erosion control and fisheries management) into an overall plan; and
- o relate economic development to the environmental capacity for that development.

14. A program should be developed to assist the municipalities with the following issues:

- o construction of wet ponds in developed areas as redevelopment occurs;

- o implementation of flow reduction techniques during redevelopment or during infrastructure rehabilitation;
- o implementation of wet ponds, disinfection and/or flow reduction techniques on a scheduled (pro-active) basis for areas which may not redevelop within a forseeable planning period; and
- o stormwater system design to provide for centralized storage facilities from a large enough catchment in existing areas as opposed to a "chicken pock" approach which might evolve from spot rezoning/spot redevelopment.

15. Opportunities such as the proposed St. Lawrence Square redevelopment should be used to demonstrate achievement of the strategy and objectives outlined in this study.

16. Education programs for controlling the usage and proper disposal of household chemicals (pesticides, herbicides, fungicides, solvents, cleaners) should be developed and implemented or enhanced in municipalities where programs exist.

17. Watershed maps and charts (by region or city) be prepared to assist Plan implementation. The charts and maps should show which control options are being protected, their current level of enforcement, and possible locations for new options, and their associated cost, environmental impact and other environmental and social amenities. Existing data helpful to auditing the success of implementation (e.g., dry weather outfall surveys, etc.) and additional auditing should be identified.

18. Rechannelization projects should be oriented toward providing a more natural habitat which is conducive toward re-establishing a warm-water fishery and/or to fish passage.

4.3 Phase 2 (long term); (i.e. 10-50 Year Time Frame)

1. The practices of constructing off-line, wet ponds and other urban BMP's in new developments, and retrofitting old areas as redevelopment occurs, should be continued.

2. Off-line ponds be constructed in the remaining built up areas within the watershed.

3. Flow reduction alternatives within residential areas should be implemented as the infrastructure is replaced or upgraded.

4. Control devices to trap floatables, oil films, spills and debris be constructed as the infrastructure is replaced.

5. The bacterial quality of existing facilities (e.g., G. Ross Lord Reservoir) and new facilities should be examined. Provision for curtains and disinfection may need to be implemented to reach body contact recreation objectives until all features of this strategy are in place.

6. The effectiveness of wet ponds or equivalent technology, and of infiltration basins for obtaining the desired levels of protection should be evaluated on an ongoing basis. These technologies should be enhanced or replaced with newer technologies (e.g., physio-chemical treatment technologies) as required to achieve the desired long-term level of protection for swimming, the fishery, and for aesthetics.

7. The following remedial programs actions already in existance, should be audited on a five year basis and replaced or updated as appropriate:

   I Sewer Systems
   - dry weather discharges,
   - cross-connections,
   - spills,
   - industrial practices,
   - residential usage of chemicals,
   - infrastructure rehabilitation,
   - conversion of dry ponds to extended dry ponds,
   - wet weather discharges (source control; SWM ponds), and
   - maintenance of pond and other control devices.

II Water Pollution Control Plants

- effluent control (MISA, operation and maintenance audits, upgrading)
- source control (MISA; model sewer use bylaw)
- sewer/WPCP system improvement.

5. Cost Estimates

Cost estimates have been prepared for the major recommendations as outlined above. The estimates, as given, should be considered as "ballpark" values and are based solely on estimates from other studies or recent projects. Estimates have not been given for several recommendations as further information is required to establish even preliminary values. However, in cases where estimates are not provided, the estimated cost is likely to be small in comparison to the other recommended options.

In some cases it has been assumed that the proposed works would be constructed as the infrastructure, due to the deteriorated condition, is replaced (e.g., provision of groundwater recharge in public sewer systems). In this case, only the additional costs, over and above the normal replacement costs, have been used. More information with respect to the cost estimates is provided in Appendix B and in Supporting Document 3.

The estimates are shown on the accompanying table. The estimates have been divided into two categories to reflect existing program costs and the estimated costs for further programs. It should be noted that the cost estimates for existing programs generally reflect costs which are directly attributable to the improvement of water quality, with the exception of sewer system costs which incorporate many goals including infrastructure replacement, basement flooding, etc. Many of these expenditures would occur over a 10-20 year time rather than for a long (i.e. 50 yr.) time frame, since 10-20 years are required to implement most of the measures.

A range of costs for off-line ponds in existing areas has been given to reflect the different levels of storms which could be treated. It is estimated that $50 million would be required to treat runoff for the average rainfall event (i.e., 5 mm) while $250 million would be required to treat runoff from a relatively severe event (i.e., 20 mm). These ponds act to reduce levels of phosphorus, suspended solids, organics and metals. They also reduce bacteria, but by an insufficient amount. Additional treatment in the form of disinfection is required. Ultraviolet irradiation cost estimates have been used in this study. They are of the same order of costs as for chlorination-dechlorination technologies without the potential environmental side effects. The cost for U.V. treatment are based upon pilot scale data for CSO's and checked with data from other sources (see Supporting Document 3).

No cost has been attributed to providing off-line ponds for future development as these costs would likely be incurred by the developer.

A range of costs has been given for redevelopment to reflect the variability in the alternatives for implementing this option.

Cost estimates have been given for storage and treatment of combined sewer overflows. As was stated previously, further work is required to establish the effectiveness or cost effectiveness of storing and treating CSO's. The estimates do, however, indicate a range of costs should these works be constructed. The estimate has been based on reducing overflows to one event per year.

The cost estimates (annual basis) as given in Table 5 may be summarized as follows:

Existing Programs

I	Current Remedial Programs (as per RAP study apportioned to Don River watershed)	($ million/year)
	- sewer system	$70
	- pollution control plants	$2.3 (most data not available)
II	Other Existing Programs	$3
	Total Existing Programs	$75.3

Proposed Programs

I	Wet Ponds - Existing Development	$4-16
II	Disinfection	$3-6
III	Flow Reduction	$6-12
IV	CSO's	$10-11
V	North Toronto STP Upgrade	$5
VI	Other New Programs	$2
VII	New Lands	$ 0.7-4
	Total Proposed Programs	$30.7-56
	TOTAL (all programs)	$106-131

TABLE 5: COST ESTIMATES FOR EXISTING PROGRAMS AND NEW REMEDIATION AND MITIGATING MEASURES

A. Costs to Local and Regional Government of Existing Programs Identified by RAP (Costs Apportioned to Don River Watershed)

			Cost ($million/year)
I.1	Sewer System		
	i) Dry Weather Discharges	- detection	8.7
		- infiltration control	6.7
	ii) Cross Connections		
	- Residential		-
	- Industrial		-
	iii) Spills		0.3
	iv) Industrial Practices		NA
	- Detection		
	- control		
	v) Residential Practices (personal ecology)		NA
	vi) Infrastructure		
	- Capital Cost		34
	- O&M		17
	- SIMS Studies		3.4
	- Total		54
	vii) Wet Weather Discharges		NA
	- Detection		
	- Pollution Abatement Programs		
	- Pilot Programs		
	viii) Combined Sewer Overflows		NA
	- Sewer Separation		
	- Inlet Control and Infrastructure		
	- Storage and Treatment		
I.2	Pollution Control Plants		
	i) Effluent Control		NA
	- MISA		
	- O&M Audits		
	- Upgrading treatment efficiency		

TABLE 5: COST ESTIMATES FOR EXISTING PROGRAMS AND NEW REMEDIATION AND MITIGATING MEASURES

		Cost ($million/year)
I.2	Pollution Control Plants (cont'd.)	
	ii) Source Control	
	- MISA sewer use control program	2.3
	- Model sewer use bylaw	NA
	iii) Sewer - STP System Improvement	
	- Sewer rehabilitation	see infrastructure
	- increased WPCP capacity	see B.16 below
II	**Other Programs**	
	1. Bylaws	
	- Pet Control	0.6
	- Plumbing	0.1
	- Sewer Use	0.7
	2. Catch BasinCleaning	1.6
	3. Hazardous Waste	10.1
	4. Aesthetics Clean-Up (General)	0.1
	Sub-Total	13.2
B.	**Additional Costs Anticipated For Don River Strategy**	
1.	Off-Line Ponds - Existing Development	
	- Construction (capital $50-250)	3-15
	- O&M	0.4
	- Disinfection (total capital equivalent $50-90)	3-6
2.	Off-line Ponds - Future Development	0
3.	Flow Reduction Through Redevelopment (Capital $100-200)	6-12
4.	Land (Ponds 170 ha; Total Costs included in 1 above)	-
5.	Storage and Treatment (CSO Control)	
	Storage (150,000 m^3)	
	- Capital ($45 million)	3
	- O&M	0.1
	Treatment	
	- Capital ($100 million)	7
	- O&M	NA
	Land (12 ha; $1-5)	0.1-0.4
6.	Control Devices (2 million)	0.1

TABLE 5: COST ESTIMATES FOR EXISTING PROGRAMS AND NEW REMEDIATION AND MITIGATING MEASURES

		Costs ($million/year)
B.	**Additional Costs Anticipated for Don River Strategy (cont'd.)**	
7.	Urban BMP's	NA
	- Source Control	
	- Inventory of Herbicides, Pesticides, Solvents	
8.	Restoration of Fishery, Birds, and Mammals	
	- Riparian Habitat	0.1
	- Charles Sauriol Conservation Reserve	0.1
	- Natural Channel Design	0.1
	- Urban Fishing	0.2
	- Fish Management Plan	0.2
9.	Suspended Solids and Erosion Control	
	- Stream Bank Stabilization in Upper Watershed	0.2
	- Construction Control and Enforcement	0.2
10.	Other Aesthetic Improvements	
	- Stream Improvement	0.1
	- Signage	0.02
11.	Land Aquisition for Recreation etc.	NA
12.	Integrated Watershed Management Plan	0.2
13.	Auditing, Implementation Changing Plan to Achieve Long Term Goals	0.1-0.5
14.	Enhancement of Existing Programs (Section A above)	NA
15.	Upgrade North Toronto STP including nitrification	5.2
16.	Education and Chemical Management	NA
Total Existing Programs		$75.3
Total Proposed Programs		$30.7-$56

Notes:
- o NA = not available.
- o Pollution Control Plants: costs given are for O and M and for upgrading North Toronto WPCP. Replacement costs of the North Toronto WPCP and for capacity for the Don River Watershed supplied by the Main WPCP are not included.

Most of the cost for the sewer system is composed of infrastructure replacement ($34 million), operation and maintenance ($17 million), and infrastructure needs studies ($3 million). These costs are estimates based upon a frequency of replacement. Existing municipal costs may not match these costs for specific fiscal years dependent upon the time when actual replacement occurs. The cost estimates for the pollution control plants include only MISA related sewer use control programs. Estimates for other large capital items such as upgrading efficiency, increased capacity etc. are not available.

The cost estimates presented above suggest that additional costs to implement the strategies advocated in this report are of the same order or smaller in magnitude than existing programs. The costs of current programs apportioned to the Don River watershed are approximately $75 million/year (Table 5). The costs of new programs for the strategies evaluated in this study would be in the range of $30-60 million/year (Table 5).

Costs estimates for achieving the different levels of protection were developed (Table 6). The cost estimates for the different levels of protection are apportioned based upon the control options described in Tables 1-3 and the cost estimates summarized in Table 5 (for the proposed programs). The following considerations entered into apportioning costs:

- New developments may be complete within a 10 year time frame. Costs for water quality control in these areas will be borne by the private sector except for certain additional costs required to maintain riverine aesthetics and the fishery.

- The management options for North Toronto STP need to be implemented for the second level of protection to provide any capability for an improved fishery in the lower river. An ongoing study will better define the preferred management options. For the purposes of this study we have assumed that the North Toronto STP would be upgraded to reduce nutrient loadings.

- Purchase of new lands or designation of existing public lands are required before substantial aesthetic improvements, fisheries related canopy and treatment plant related works can be instituted.

TABLE 6: SUMMARY OF COST ESTIMATES FOR DIFFERENT LEVELS OF PROTECTION

Level of Protection	Proposed Programs Annual Cost ($ million/yr.)	Proposed Programs Present Value Cost ($ million)	Existing & Proposed Programs Annual Cost ($ million/yr.)	Existing & Proposed Programs Present Value Cost ($ million)
1. Status Quo	4-5	65-80	79-80	1300
2. Limited Aesthetic Water Quality & Fishery Improvements	12-15	200-250	87-90	1400-1500
3. Substantial WQ and Aesthetic Improvement; establish urban sports fishery in upper watershed	17-27	300-450	92-100	1500-1700
4. Body contact recreation most times throughout river; warm water fishery throughout watershed; periodic problems with aquatic aesthetics	28-36	450-600	103-110	1700-1800
5. Body contact recreation at all times; migratory warm water fishery; hatchery maintained cold water fishery; aesthetically acceptable by all conventional standards	45-56	750-900	120-130	2000-2100

- Retrofitting of wet ponds will take substantial time to implement; retrofitting as redevelopment occurs to permit flow control (infiltration basins) will occur over even longer period of time.

- Retrofitting with wet ponds (or equivalent technology) and flow control (infiltration basins) would be designed to handle small events (5 mm storms as indicated in Tables 1-3) for the third level of protection increasing to large events (20 mm storms) for the fifth level of protection (as indicated in Table 1-3).

- Wet ponds and flow control would have a significant impact upon bacterial densities for the Levels of Protection 1-3. It is assumed that 5 demonstration facilities are instituted for the second level of protection, that 10% of the ponds are designed with disinfection to handle small events for the third level of protection. This increases to 100% of the wet ponds having disinfection to handle large (20 mm) events for the fifth level of protection.

- CSO overflow points are controlled with wet ponds (or equivelent technology) of increasing size to assist in the improvements of aesthetics and reduction of bacterial loadings for the first to third levels of protection. CSO overflows are controlled with storage and treatment methods to achieve the fifth level of protection. The fifth level uses larger storage volume than the fourth level to control to one overflow per year.

GLOSSARY OF ACRONYMS

RAP:	Remedial Action Plan
TAWMS:	Toronto Area Watershed Management Strategy
WWQIP:	Waterfront Water Quality Improvement Program
SWM:	Stormwater Management
SWMAT:	Stormwater Management and Treatment
IRP:	Infrastructure Rehabilitation Program
MISA:	Municipal Industrial Strategy for Abatement
WPCP:	Water Pollution Control Plant
STP:	Sewage Treatment Plant (another name for the WPCP)
WTP:	Water Treatment Plant
Metro:	Metropolitan Toronto
HSI:	Habitat Suitability Index
SCOUR:	Stream Cleanup (an MTRCA program for River Valleyland Cleanup)
MTRCA:	Metropolitan Toronto Region Conservation Authority
BMP's:	Best Management Practices
CSO:	Combined Sewer Overflow
STP:	Sewage Treatment Plant
Wet Pond:	A storage facility (open air) which contains a pool of water
extended dry-pond:	A storage facility (open air) which is normally dry except for a portion which has a permanent pool of water
in-line:	a facility is denoted as in-line if it is located within the banks of the watercourse
off-line:	a facility is denoted as off-line if it is located outside the banks of the water course

APPENDIX A

DISCUSSION OF SPREADSHEET DATA

APPENDIX A: DISCUSSION OF SPREADSHEET DATA

The analytical techniques, the associated assumptions and the results of the spreadsheet calculations are given in Supporting Document 1. A few relevant figures and tables are extracted from this document and discussed here.

Methods

The following approach was used to estimate riverine loadings and associated concentrations.

1. A flow model was developed which described flow coming from storm sewer systems, combined sewer overflows, rural (non-urban) areas, and the North Toronto Sewage Treatment Plant.

2. The individual sources of flow were established as follows:

   i) The response of separated storm sewer system to rainfall was estimated for generic catchments for different sizes of rainfall using the SWMM model.

   ii) CSO volumes of runoff were estimated with a statistical (derived probability) methodology and checked with volumes of overflow to rainfall relationships developed by Pollution Control Plans for the Borough of East York and the City of Scarborough.

   iii) Dry weather flow estimates were initially based upon field measurements and then adjusted to obtain agreement with the observed data.

   iv) North Toronto STP flow data were taken from records.

3. The flow model was compared to observed flows at the Water Survey of Canada station at Todmorden for the 1986 hydrological year.

4. The concentrations of contaminants from different sources were estimated from the literature and checked with available measurements.

5. The source concentrations were adjusted as necessary to get agreement between calculations and observations at the Todmorden water quality sampling station for:

   i) time-weighted concentrations; and
   ii) flow-weighted concentrations.

Results

The results of the calculations for the reference hydrological year, 1986, are shown in the form of pie charts for different conditions (dry, 5 mm, 10 mm, 15 mm storms) for the upper Don (Figures 8-11), the Middle Don (Figures 12-15), the lower Don (Figures 16-19), and for Massey Creek (Figures 20-23). The figure numbers are those used in Supporting Document 1.

The effects of water quality control are documented and compared to values for existing conditions and target values in Tables 14 to 17. The results are given in the tables as follows. These table numbers are also those used in Supporting Document 1.

i) Table 14 ... dry conditions and 5 mm storm for Upper and Middle River;

ii) Table 15 ... dry conditions and 5 mm storm for the Lower River and Massey Creek;

iii) Table 16 ... 10 mm and 20 mm storm for Upper and Middle River; and

iv) Table 17 ... 10 mm and 20 mm storm for Lower River and Massey Creek.

The effects of control upon instream water quality were modelled using the following formula:

$$C_{RIVER} = \frac{SSS(C_{SOURCE}*(1-R_3)(1-R_1))\ Q_{SOURCE}(1-R_2)}{SSS\ Q_{SOURCE}\ (1-R_2)}$$

Here: SSS is the sum over all sources;

C_{SOURCE} is the concentration in any source i;

Q_{SOURCE} is the flow rate (or daily flow volume) for each source i;

C_{RIVER} is the riverine concentration

R_1 is the amount of source concentration reduction caused by control;

R_2 is the amount of flow reduction caused by control;

R_3 is the amount of removal which occurs due to instream processes.

The control options considered will impact either the concentration or the volume of water discharged to the river. The following values were used to estimate R_1 for concentration:

	Option	SS	TP	Ammonia	Copper	Lead	FC
1.	North Toronto STP Upgrade	0	0.4	0.5	0.0	0.0	0.0
2.	North Toronto STP Removal	0.0	0.0	0.0	0.0	0.0	0.0
3.	CSO Control	0.0	0.0	0.0	0.0	0.0	0.0
4.	SWM (Wet) Ponds	0.8	0.5	0.2	0.4	0.7	0.2
5.	Urban/Rural Maintenance	0.1	0.1	0.1	0.1	0.1	0.1
6.	Urban/Rural BMP's	0.3	0.3	0.0	0.3	0.3	0.9
7.	Urban Infiltration Control	0.0	0.0	0.0	0.0	0.0	0.0

The following values were used to estimate R_2 for the effects of control upon flow:

	Control Option	Reduction Factor for Particular Source	
1.	North Toronto STP Upgrade	0.0	
2.	North Toronto STP Removal	1.0	
3.	CSO Control	0.9	
4.	SWM Ponds	0.0	
5.	Urban/Rural Maintenance	0.0	
6.	Urban/Rural BMP's	0.0	
7.	Urban Infiltration Control	0.6	dependent upon storm volume

The following considerations were used to establish the effects of control upon runoff volume.

The "North Toronto STP removal" completely removes the STP effluent from the river. Hence, the flow reduction factor (R_2) is assigned a value of 1 (see Table 13b) while the discharge concentration is not affected. CSO control is assumed to remove 90% of the volume of water presently discharged to the watershed from combined sewer overflows. Urban infiltration control induces infiltration of stormwater runoff into the ground. Assuming that all the infiltrating water eventually returns to the watershed, one would assign the reduction factor for flow (R_2) equal to 0, and the reduction factor for concentration, (R_1), equal to 0.6, assuming that 50% of urban runoff infiltrates first to the ground. In this work, an alternative approach was used for evaluation of events by assigning $R_1 = 0$ and $R_2 = 0.6$. This assumes that infiltrating rain water does not reach the river during the time scale of the event. The effects upon base flow require further attention.

The other removal factors for concentration are based upon the following assumptions. For an STP upgrade, a variety of methods can be used. Most would involve extra treatment units. It was assumed that additional injection of chemicals to precipitate more phosphorus (perhaps two stage injection) and partial nitrification of the effluent would result in the removals given. It was assumed that clarifier improvements would not substantially change the removal of suspended solids and metals. It was also assumed that chlorination would not become significantly more efficient since present operating data indicate low values for the number of fecal coliform discharged in the effluent to the river.

The removal factors for SWM ponds, maintenance and BMP's are based upon field data from the NURP (National Urban Runoff Program) monitoring program in the U.S. and TAWMS estimates. Bacterial removals in ponds range from negligible to more than 90% (with residence times of 2-4 days). Assuming that space limitations may preclude the large sizes of ponds required to achieve these long residence times, a small removal factor was assigned. Other plausible values of 0.9 for fecal coliforms were tested with a sensitivity analysis.

The modelling of instream processes was carried out only for bacteria. For bacteria in the Lower Don River for example, R_3 was assigned a value of 0.9 when bacteria originating from upstream sources are considered. These processes were incorporated into the spreadsheet by formulating C_{SOURCE} $(1-R_3)$ into an equivalent value for concentration.

The results of the calculations as indicated in Tables 14 to 17 are straight forward and are discussed in the main text. It is useful to make the following points about the results:

i) all units are in mg/L except fecal coliforms which are in counts/100 mL;

ii) the STP control options only involve the lower river because of the location of the plant; the CSO control options mainly affect Massey Creek and the lower river due to their location in these reaches; and

iii) the following points are made specifically for bacteria control:

   a) one figure accuracy is generally used in reporting the results,

   b) the effects of disinfection are not considered as a control option in Tables 14 to 17; removal results only from CSO control, from removal processes in the ponds, and due to groundwater interception of infiltrating stormwater, and

   c) these control measures result in fecal coliforms densities which are generally one and one-half orders of magnitude above target values for event conditions.

      An increase of FC removals in off-line wet ponds from 20% to 90% results in FC densities which are still an order of magnitude higher than target values in wet conditions. However, fecal coliform removals of 90% in wet ponds during dry weather conditions might result in riverine bacterial densities which approach target values throughout much of the Don River watershed during dry weather conditions. These lower densities for dry

weather conditions would occur only after a suitably long period after an event (1-2 days) to allow a complete flushing of the river system.

REACH: UPPER DON RIVER

CONDITION: DRY

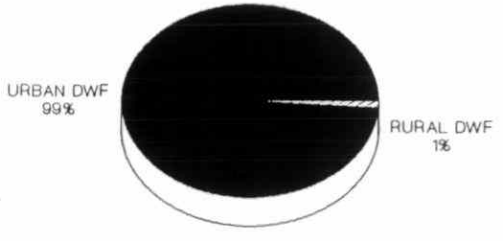
COPPER

LOADING LESS THAN 1 KG/DAY FROM EACH SOURCE

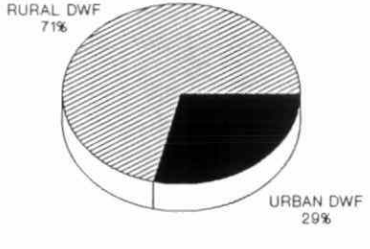
LEAD

LOADING LESS THAN 1 KG/DAY FROM EACH SOURCE

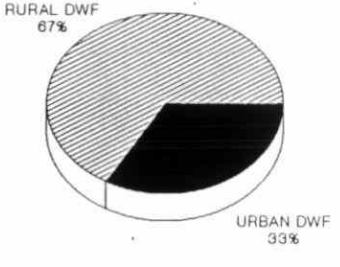
FC



SS



TP



AMMONIA

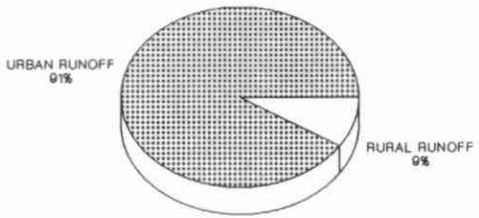
LOADING LESS THAN 1 KG/DAY FROM EACH SOURCE

RELATIVE SOURCE LOADINGS

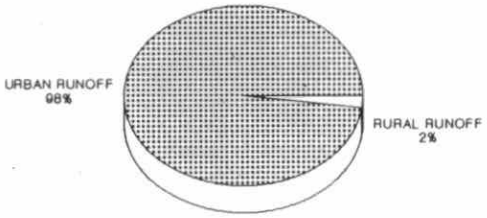
FIGURE 8

REACH: UPPER DON RIVER CONDITION: 5 mm STORM

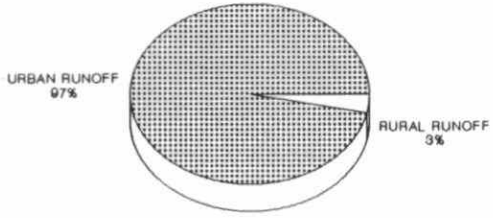
COPPER



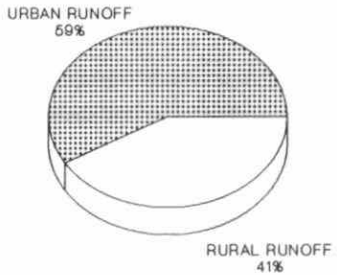
LEAD



FC



SS



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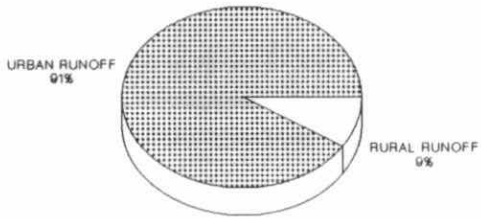
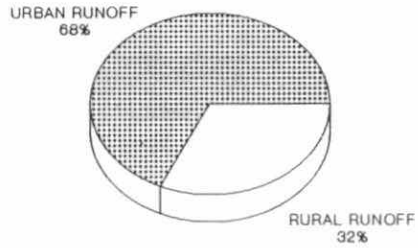


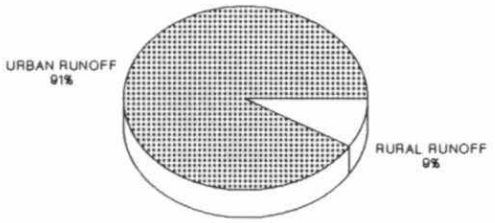
AMMONIA



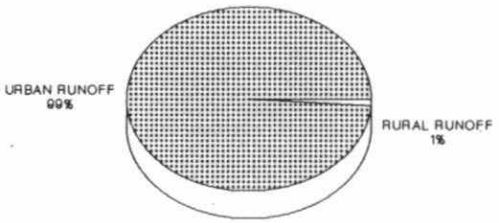
RELATIVE SOURCE LOADINGS FIGURE 9

REACH: UPPER DON RIVER CONDITION: 10 mm STORM

COPPER



LEAD



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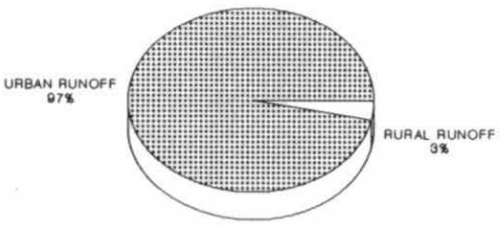

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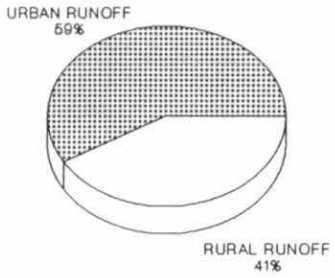

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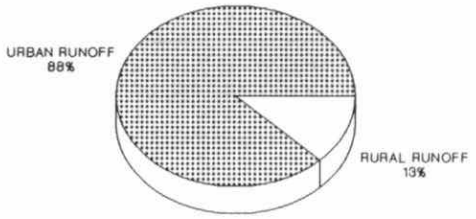

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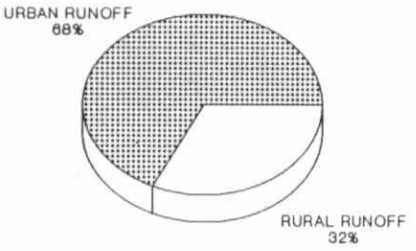
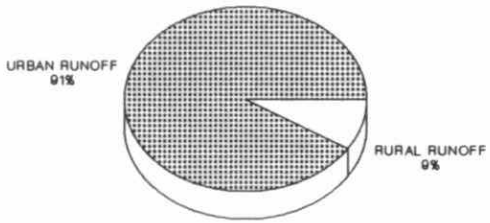


RELATIVE SOURCE LOADINGS FIGURE 10

REACH: UPPER DON RIVER CONDITION: 20 MM STORM

COPPER



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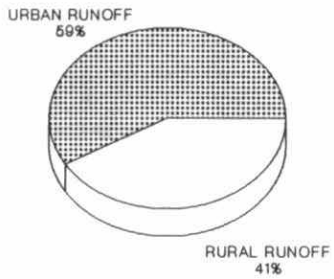
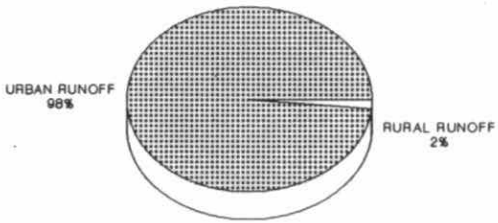


LEAD



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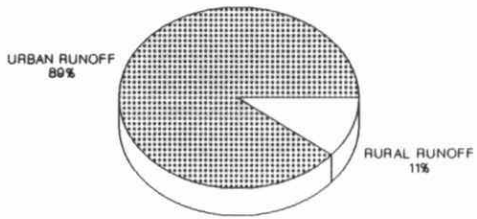

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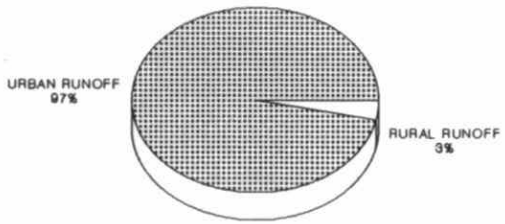

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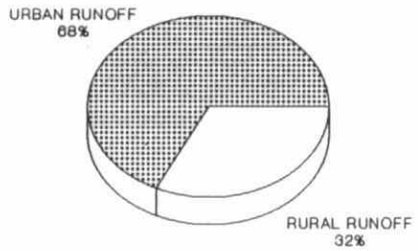


RELATIVE SOURCE LOADINGS **FIGURE 11**

REACH: MIDDLE DON RIVER

CONDITION: DRY

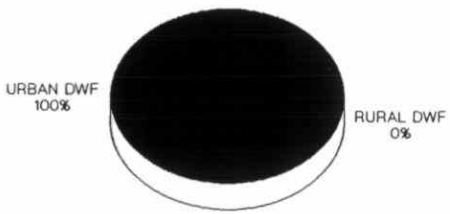
COPPER

LOADINGS LESS THAN 1 KG/DAY FROM EACH SOURCE

LEAD

LOADING LESS THAN 1 KG/DAY FROM EACH SOURCE

FC



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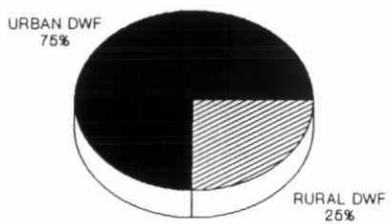

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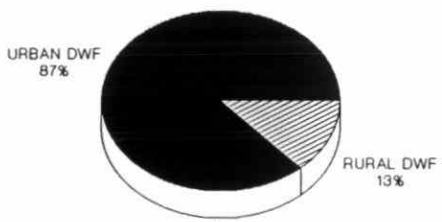


AMMONIA

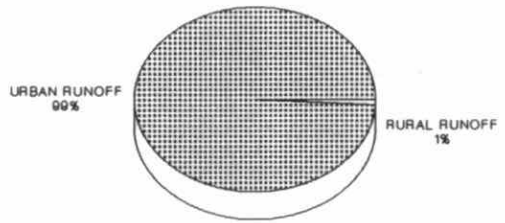
LOADINGS LESS THAN 1 KG/DAY FROM EACH SOURCE

RELATIVE SOURCE LOADINGS

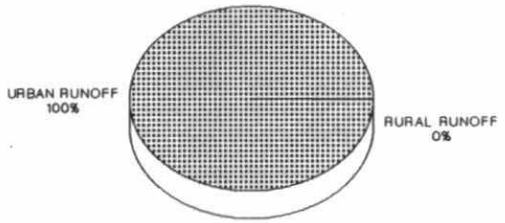
FIGURE 12

REACH: MIDDLE DON RIVER CONDITION: 5 MM STORM

COPPER



LEAD



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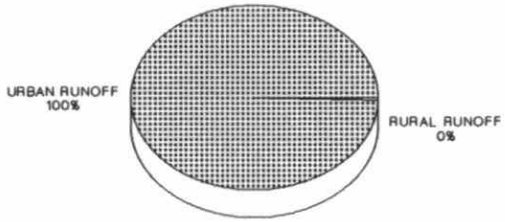

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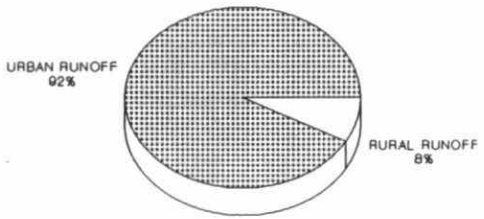

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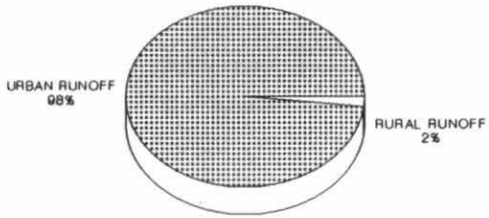

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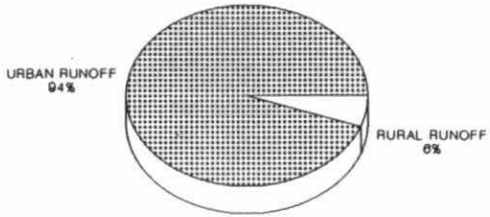
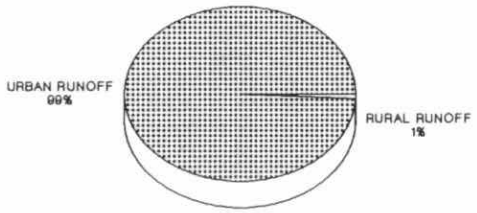


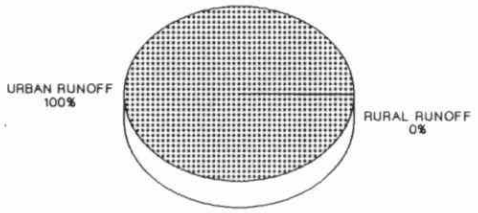
RELATIVE SOURCE LOADINGS FIGURE 13

REACH: MIDDLE DON RIVER CONDITION: 10 MM STORM

COPPER



LEAD



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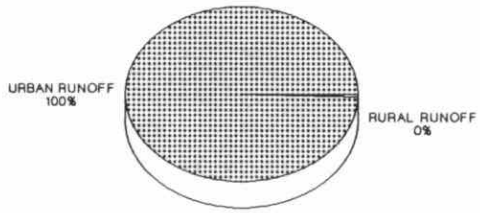

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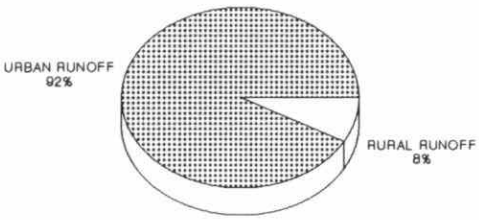

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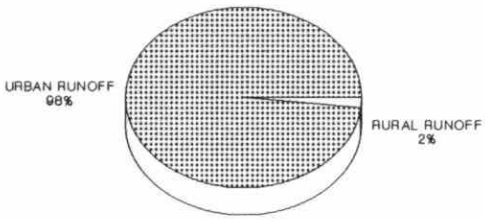

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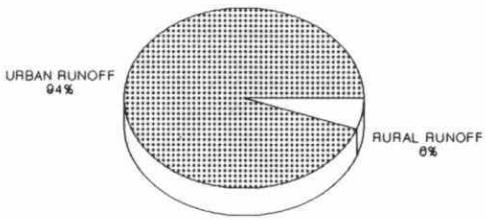
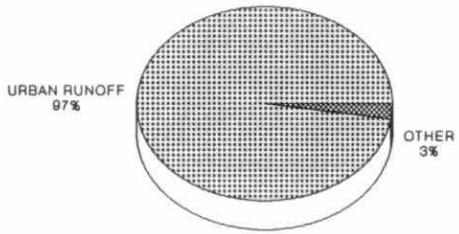


RELATIVE SOURCE LOADINGS FIGURE 14

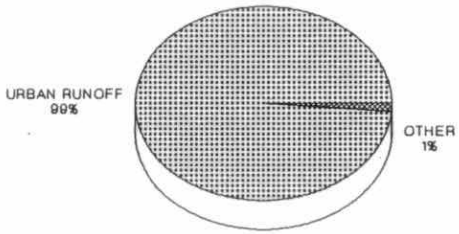
REACH: MIDDLE DON RIVER CONDITION: 20 MM STORM

COPPER



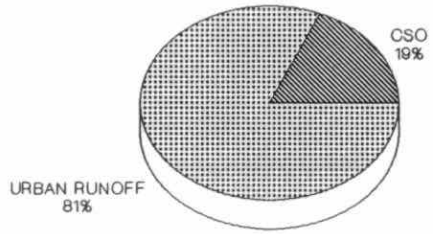
SS

LEAD



TP

FC



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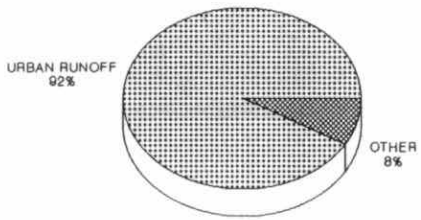
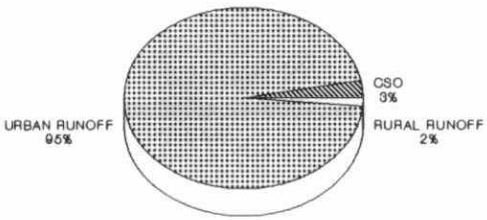
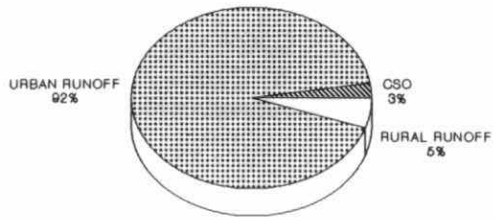
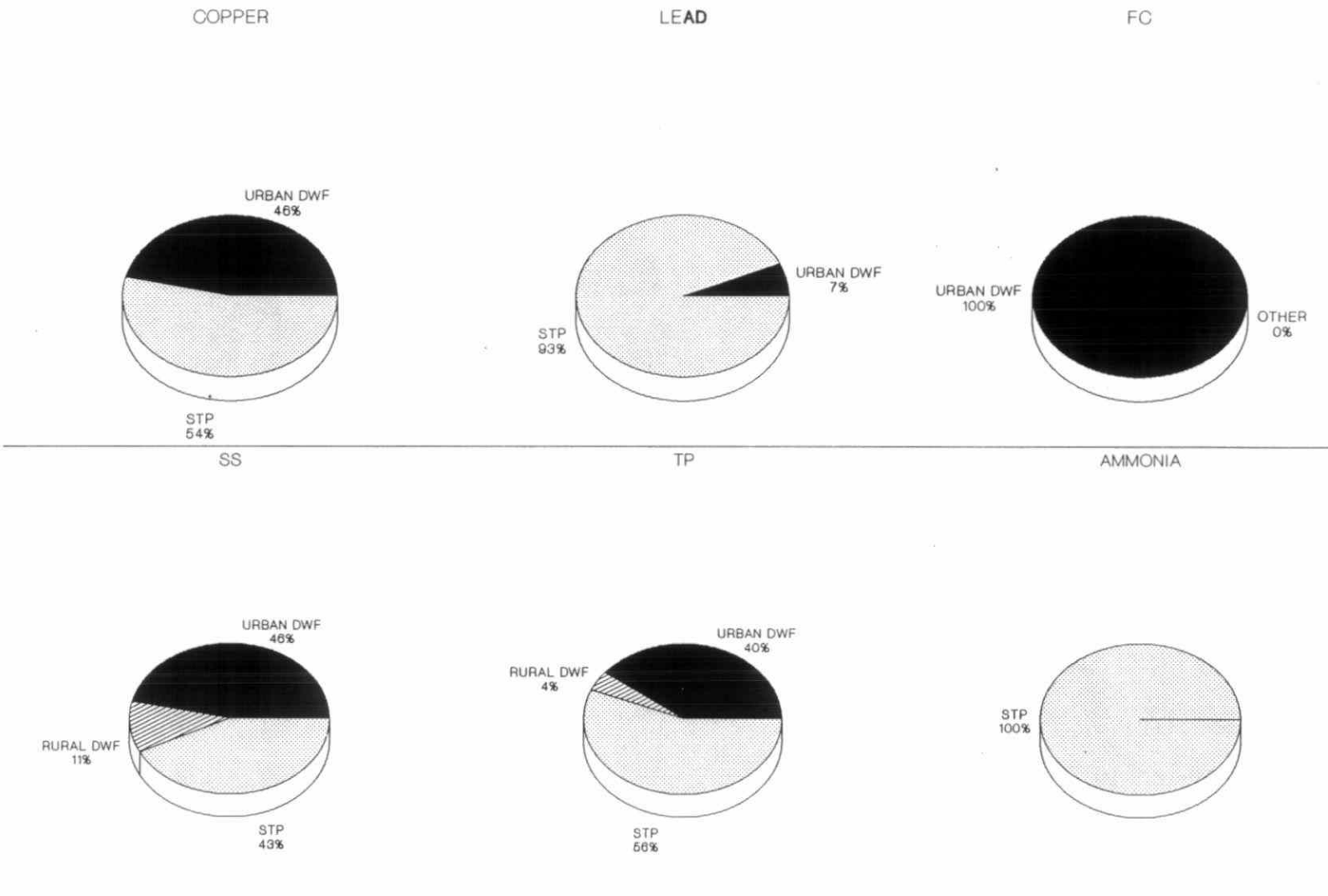






RELATIVE SOURCE LOADINGS FIGURE 15

REACH: LOWER DON RIVER CONDITION: DRY

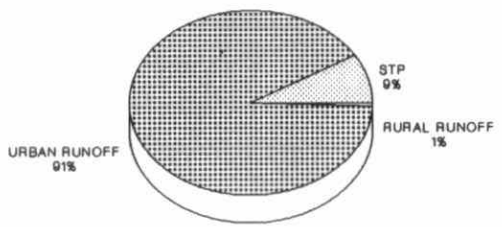


RELATIVE SOURCE LOADINGS

FIGURE 16

REACH: LOWER DON RIVER CONDITION: 5MM STORM

CU LEAD FC



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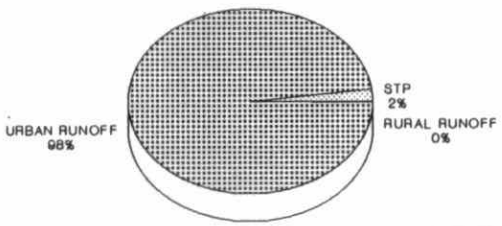

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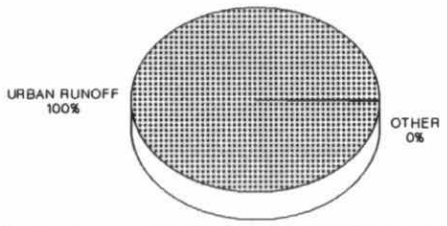

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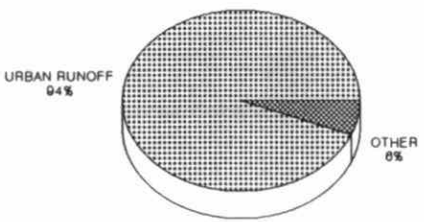
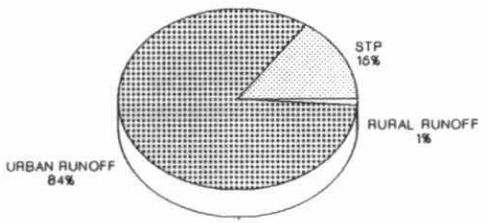
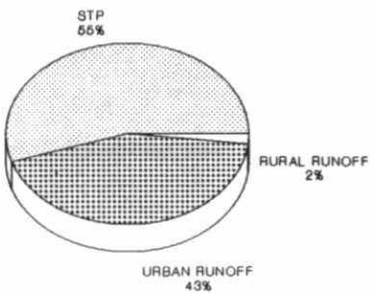
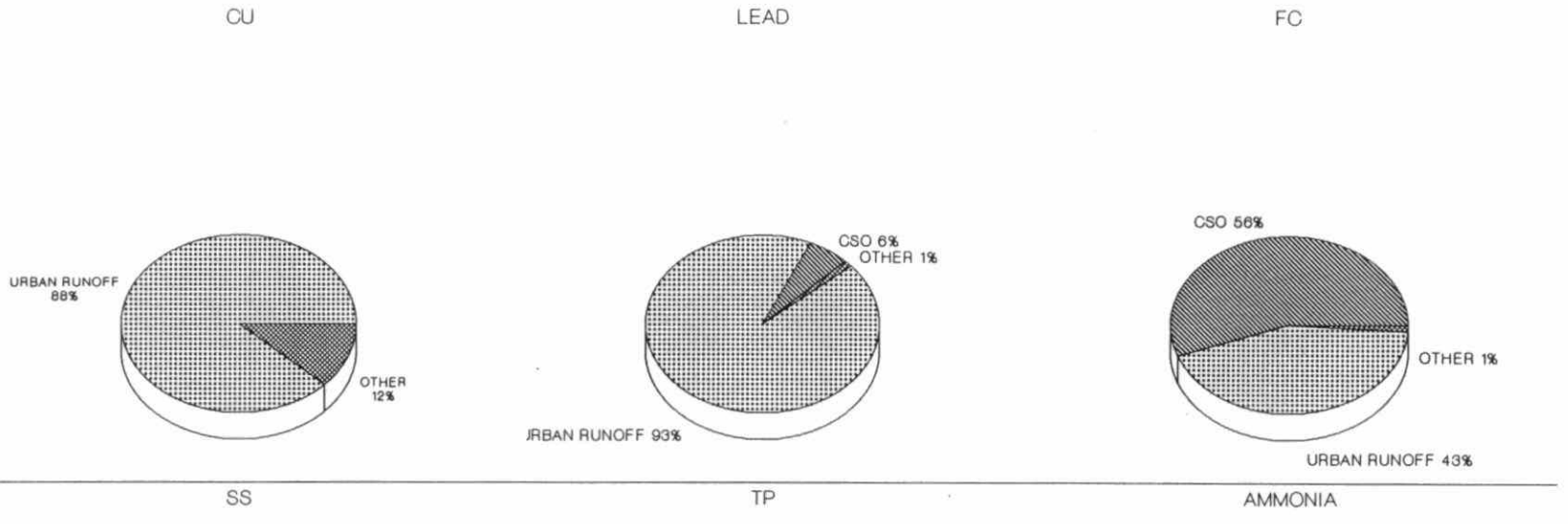






RELATIVE SOURCE LOADINGS FIGURE 17

REACH: LOWER DON RIVER CONDITIONS: 10 MM STORM

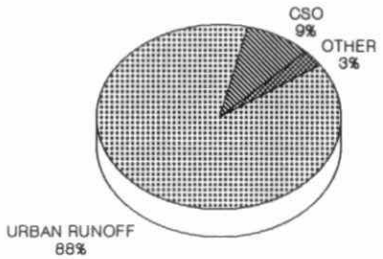


RELATIVE SOURCE LOADINGS

FIGURE 18

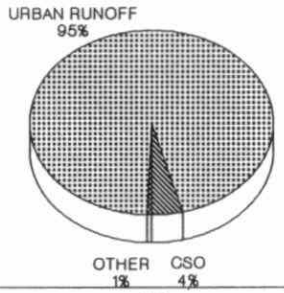
REACH: LOWER DON RIVER CONDITION: 20 MM STORM

COPPER



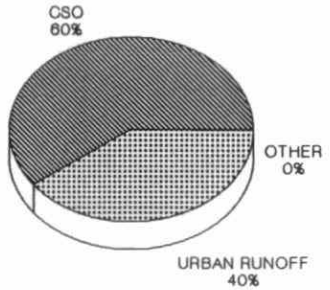
SS

LEAD

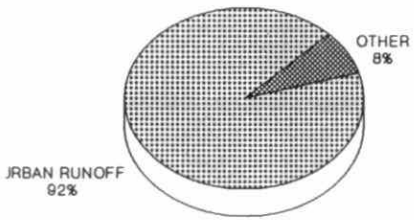


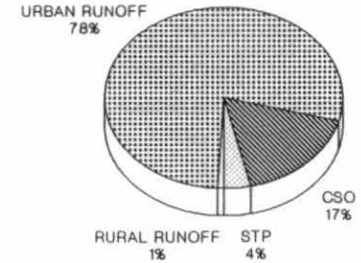
TP

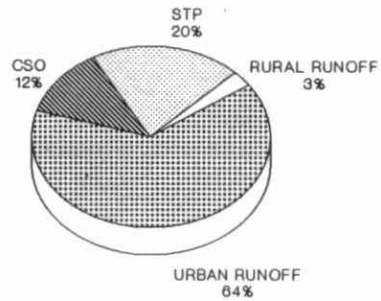
FC



AMMONIA







RELATIVE SOURCE LOADINGS FIGURE 19

REACH: MASSEY CREEK

CONDITION: DRY

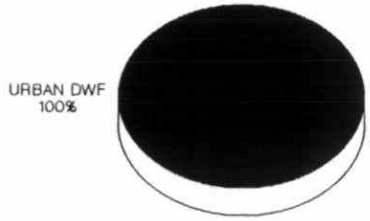
COPPER

LOADING LESS THAN 1 KG/DAY FROM EACH SOURCE

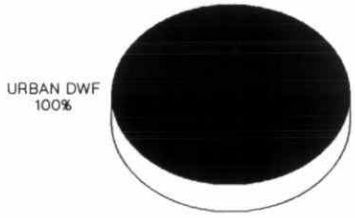
LEAD

LOADING LESS THAN 1 KG/DAY FROM EACH SOURCE

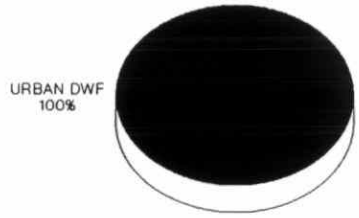
FC



SS



TP



AMMONIA

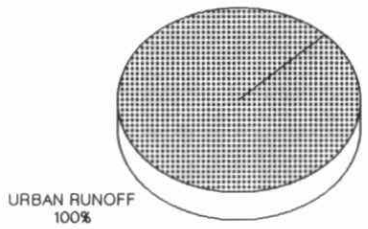
LOADING LESS THAN 1 KG/DAY FROM EACH SOURCE

RELATIVE SOURCE LOADINGS

FIGURE 20

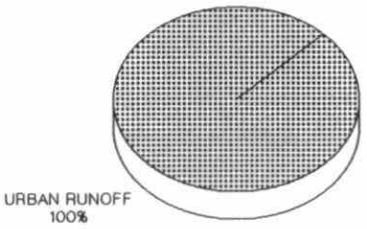
REACH: MASSEY CREEK CONDITION: 5 MM STORM

COPPER



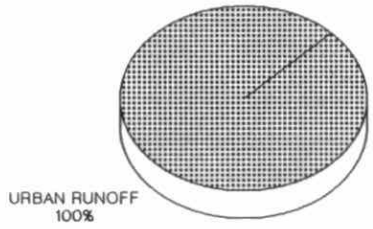
SS

LEAD

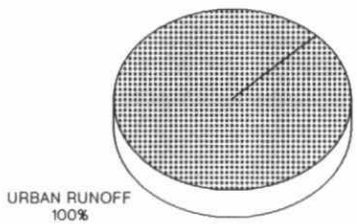


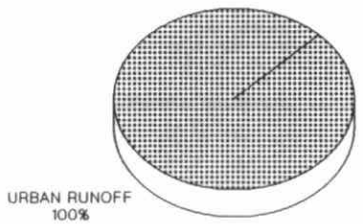
TP

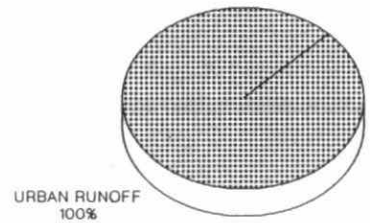
FC



AMMONIA

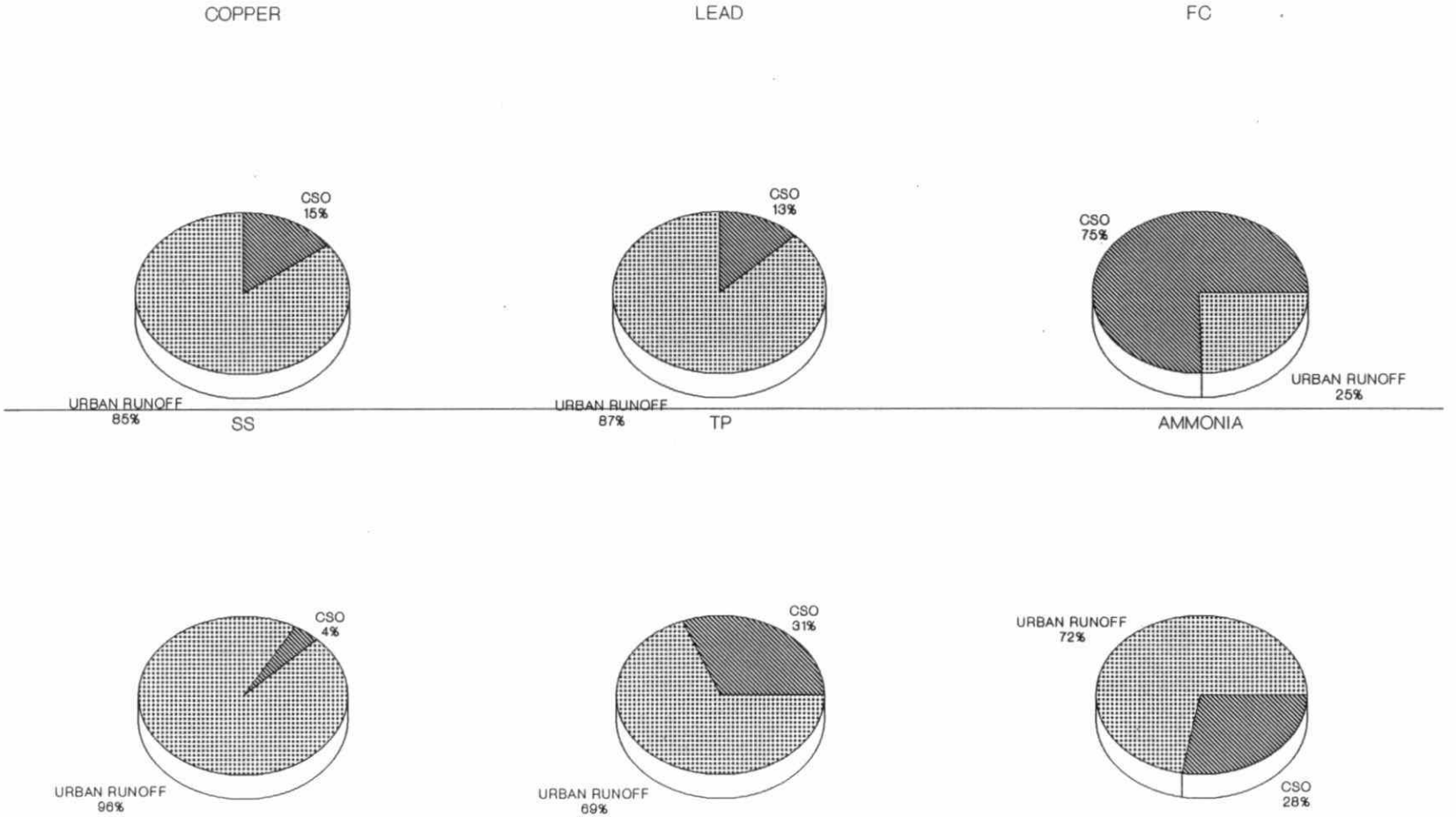






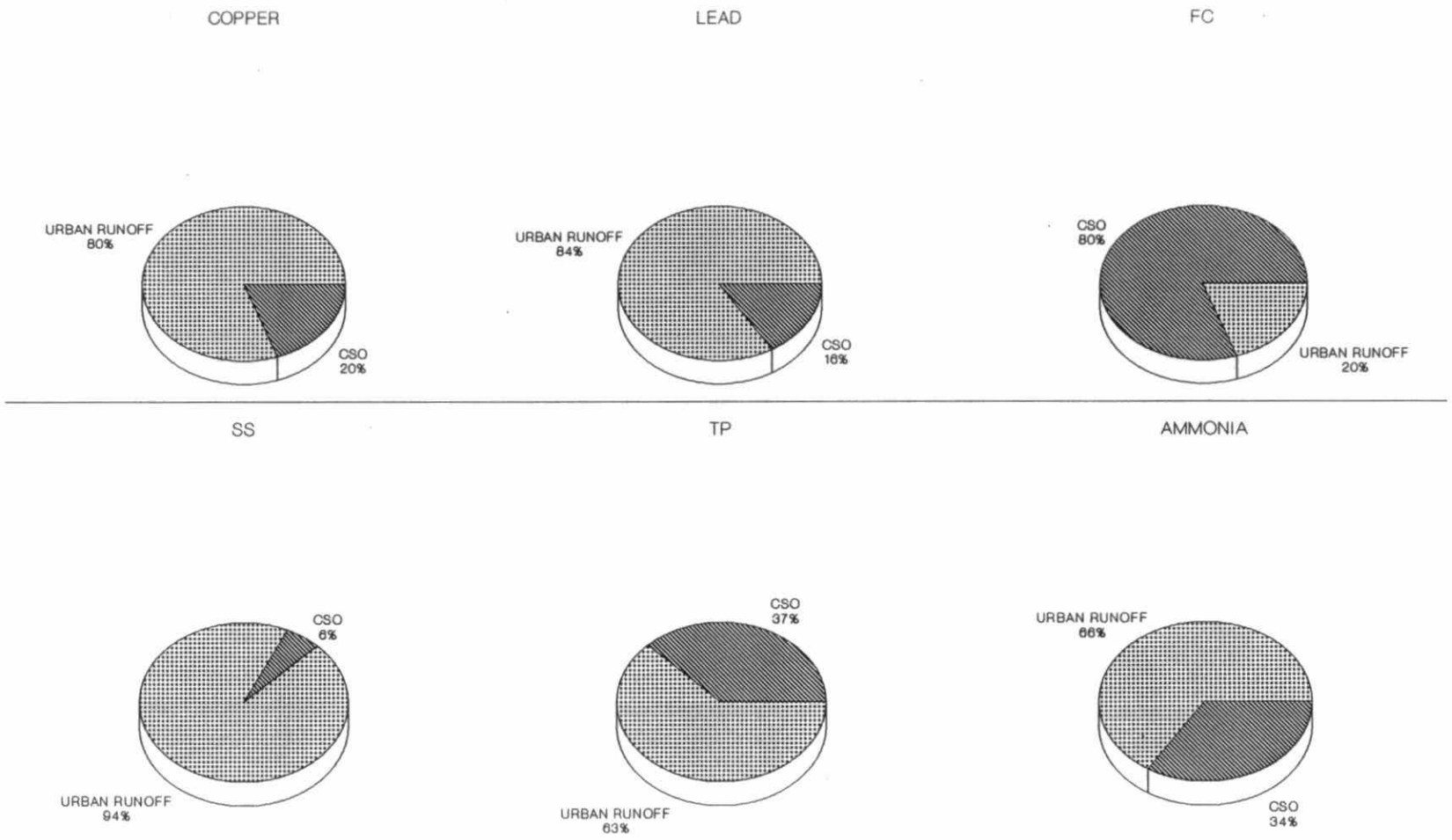
RELATIVE SOURCE LOADINGS **FIGURE 21**

REACH: MASSEY CREEK CONDITION: 10 MM STORM



RELATIVE SOURCE LOADINGS FIGURE 22

REACH: MASSEY CREEK CONDITION: 20 MM STORM



RELATIVE SOURCE LOADINGS FIGURE 23

TABLE 14

CONTROL OPTION SUMMARIES — BASED ON 50th PERCENTILE EXISTING CONCENTRATIONS

DON RIVER REACH: UPPER DON RIVER
PRECIPITATION CONDITIONS: DRY

	OPTION	CONCENTRATIONS (mg/l) * PARAMETER SS	TP	AMMONIA	COPPER	LEAD	FC
1	STP UPGRADE	5	0.19	0.01	0.006	0.002	700
2	STP REMOVAL	5	0.19	0.01	0.006	0.002	700
3	CSO 90% REMOVAL	5	0.19	0.01	0.006	0.002	700
4A	URBAN OFFLINE WET PONDS	5	0.19	0.01	0.006	0.002	700
4B	URBAN/RURAL INLINE POND	5	0.19	0.01	0.006	0.002	700
5	URBAN AND RURAL WET AND DRY MAINTENANCE	5	0.17	0.01	0.005	0.002	700
6	URBAN AND RURAL WET AND DRY BMP	4	0.14	0.01	0.005	0.001	700
7	URBAN FLOW CONTROL	5	0.19	0.01	0.006	0.002	700
8	URBAN OFFLINE PONDS AND FLOW CONTROL	5	0.19	0.01	0.006	0.002	700
9	ALL (3-7) WITH STP REMOVAL	3	0.10	0.01	0.003	0.001	500
	EXISTING	5	0.19	0.01	0.006	0.002	700
	TARGET VALUE	200	0.10		0.005	0.025	100

DON RIVER REACH: MIDDLE DON RIVER
PRECIPITATION CONDITIONS: DRY

	CONCENTRATIONS (mg/l) PARAMETER SS	TP	AMMONIA	COPPER	LEAD	FC
	5	0.27	0.01	0.016	0.002	2000
	5	0.27	0.01	0.016	0.002	2000
	5	0.27	0.01	0.016	0.002	2000
	5	0.27	0.01	0.016	0.002	2000
	5	0.27	0.01	0.016	0.002	2000
	5	0.24	0.01	0.015	0.002	2000
	4	0.24	0.01	0.015	0.002	2000
	5	0.27	0.01	0.016	0.002	2000
	5	0.27	0.01	0.016	0.002	2000
	1	0.12	0.01	0.008	0.001	1500
	5	0.27	0.01	0.016	0.002	2000
	200	0.10		0.005	0.025	100

DON RIVER REACH: UPPER DON RIVER
PRECIPITATION CONDITIONS: 5 mm

	OPTION	CONCENTRATIONS (mg/l) PARAMETER SS	TP	AMMONIA	COPPER	LEAD	FC
1	STP UPGRADE	188	0.19	0.19	0.015	0.056	4000
2	STP REMOVAL	188	0.19	0.19	0.015	0.056	4000
3	CSO 90% REMOVAL	188	0.19	0.19	0.015	0.056	4000
4A	URBAN OFFLINE WET PONDS	113	0.13	0.17	0.010	0.018	3000
4B	URBAN/RURAL INLINE POND	39	0.12	0.15	0.010	0.017	3000
5	URBAN AND RURAL WET AND DRY MAINTENANCE	170	0.17	0.17	0.014	0.050	4000
6	URBAN AND RURAL WET AND DRY BMP	151	0.16	0.18	0.013	0.050	4000
7	URBAN FLOW CONTROL 80%	113	0.19	0.10	0.005	0.012	1000
8	URBAN OFFLINE PONDS AND FLOW CONTROL	98	0.13	0.09	0.004	0.005	1000
9	ALL (3-7) WITH STP REMOVAL	62	0.09	0.08	0.003	0.004	600
	EXISTING	188	0.19	0.19	0.015	0.056	4000
	TARGET VALUE	200	0.10		0.005	0.025	100

DON RIVER REACH: MIDDLE DON RIVER
PRECIPITATION CONDITIONS: 5 mm

	CONCENTRATIONS (mg/l) PARAMETER SS	TP	AMMONIA	COPPER	LEAD	FC
	213	0.31	0.25	0.029	0.114	8000
	213	0.31	0.25	0.029	0.114	8000
	213	0.31	0.25	0.029	0.114	8000
	55	0.18	0.20	0.018	0.035	7000
	43	0.17	0.20	0.018	0.034	7000
	191	0.27	0.22	0.026	0.103	7000
	188	0.27	0.23	0.026	0.103	7000
	55	0.11	0.06	0.008	0.023	2000
	23	0.08	0.05	0.006	0.007	2000
	16	0.05	0.04	0.004	0.006	1000
	213	0.31	0.25	0.029	0.074	8000
	200	0.10		0.005	0.025	100

NOTES: UNITS FOR FECAL COLIFORM ARE counts/100ml.

TABLE 15

CONTROL OPTION SUMMARIES — BASED ON 50th PERCENTILE EXISTING CONCENTRATIONS

DON RIVER REACH: LOWER DON RIVER
PRECIPITATION CONDITIONS: DRY

		CONCENTRATIONS (mg/l)					
		PARAMETER					
	OPTION	SS	TP	AMMONIA	COPPER	LEAD	FC
1	STP UPGRADE	6	0.34	0.78	0.024	0.014	2000
2	STP REMOVAL	3	0.19	0.01	0.011	0.001	2000
3	CSO 90% REMOVAL	6	0.43	1.55	0.024	0.014	2000
4A	URBAN OFFLINE WET PONDS	6	0.43	1.55	0.024	0.014	2000
4B	URBAN/RURAL INLINE POND	6	0.43	1.55	0.024	0.014	2000
5	URBAN AND RURAL WET AND DRY MAINTENANCE	6	0.42	1.55	0.023	0.014	2000
6	URBAN AND RURAL WET AND DRY BMP	6	0.41	1.55	0.022	0.014	2000
7	URBAN FLOW CONTROL	6	0.43	1.55	0.024	0.014	2000
8	URBAN OFFLINE PONDS AND FLOW CONTROL	6	0.43	1.55	0.024	0.014	2000
9	ALL (3-7) WITH STP REMOVAL	1	0.08	<.01	0.006	<.001	1000
	EXISTING	6	0.43	1.55	0.024	0.014	2000
	TARGET VALUE	200	0.10		0.005	0.025	100

DON RIVER REACH: MASSEY CREEK
PRECIPITATION CONDITIONS: DRY

		CONCENTRATIONS (mg/l)					
		PARAMETER					
	OPTION	SS	TP	AMMONIA	COPPER	LEAD	FC
1	STP UPGRADE	5	0.30	0.01	0.020	0.002	3000
2	STP REMOVAL	5	0.30	0.01	0.020	0.002	3000
3	CSO 90% REMOVAL	5	0.30	0.01	0.020	0.002	3000
4A	URBAN OFFLINE WET PONDS	5	0.30	0.01	0.020	0.002	3000
4B	URBAN/RURAL INLINE POND	5	0.30	0.01	0.020	0.002	3000
5	URBAN AND RURAL WET AND DRY MAINTENANCE	5	0.27	0.01	0.018	0.002	3000
6	URBAN AND RURAL WET AND DRY BMP	5	0.27	0.01	0.018	0.002	3000
7	URBAN FLOW CONTROL	5	0.30	0.01	0.020	0.002	3000
8	URBAN OFFLINE PONDS AND FLOW CONTROL	5	0.30	0.01	0.020	0.002	3000
9	ALL (3-7) WITH STP REMOVAL	0	0.12	0.01	0.010	<.001	2000
	EXISTING	5	0.30	0.01	0.020	0.002	3000
	TARGET VALUE	200	0.10		0.005	0.025	100

DON RIVER REACH: LOWER DON RIVER
PRECIPITATION CONDITIONS: 5 mm

		CONCENTRATIONS (mg/l)					
		PARAMETER					
	OPTION	SS	TP	AMMONIA	COPPER	LEAD	FC
1	STP UPGRADE	204	0.32	0.39	0.030	0.113	8000
2	STP REMOVAL	203	0.29	0.24	0.027	0.110	8000
3	CSO 90% REMOVAL	204	0.34	0.53	0.030	0.113	8000
4A	URBAN OFFLINE WET PONDS	51	0.21	0.49	0.020	0.036	6000
4B	URBAN/RURAL INLINE POND	42	0.21	0.48	0.020	0.036	6000
5	URBAN AND RURAL WET AND DRY MAINTENANCE	184	0.31	0.51	0.027	0.101	7000
6	URBAN AND RURAL WET AND DRY BMP	181	0.31	0.51	0.027	0.101	7000
7	URBAN FLOW CONTROL 80%	51	0.14	0.35	0.010	0.025	2000
8	URBAN OFFLINE PONDS AND FLOW CONTROL	21	0.11	0.34	0.008	0.009	2000
9	ALL (3-7) WITH STP REMOVAL	14	0.04	0.04	0.004	0.005	1000
	EXISTING	204	0.34	0.53	0.300	0.113	8000
	TARGET VALUE	200	0.10		0.005	0.025	100

DON RIVER REACH: MASSEY CREEK
PRECIPITATION CONDITIONS: 5 mm

		CONCENTRATIONS (mg/l)					
		PARAMETER					
	OPTION	SS	TP	AMMONIA	COPPER	LEAD	FC
1	STP UPGRADE	215	0.33	0.26	0.031	0.124	9000
2	STP REMOVAL	215	0.33	0.26	0.031	0.124	9000
3	CSO 90% REMOVAL	215	0.33	0.26	0.031	0.124	9000
4A	URBAN OFFLINE WET PONDS	44	0.18	0.21	0.020	0.037	7000
4B	URBAN/RURAL INLINE POND	44	0.18	0.21	0.020	0.037	7000
5	URBAN AND RURAL WET AND DRY MAINTENANCE	194	0.29	0.23	0.028	0.111	8000
6	URBAN AND RURAL WET AND DRY BMP	194	0.29	0.23	0.028	0.111	8000
7	URBAN FLOW CONTROL 80%	44	0.10	0.05	0.009	0.025	2000
8	URBAN OFFLINE PONDS AND FLOW CONTROL	9	0.07	0.04	0.006	0.008	2000
9	ALL (3-7) WITH STP REMOVAL	7	0.04	0.03	0.004	0.006	1000
	EXISTING	215	0.33	0.26	0.031	0.124	9000
	TARGET VALUE	200	0.10		0.005	0.025	100

NOTES: UNITS FOR FECAL COLIFORM ARE counts/100ml.

TABLE 16

DON RIVER REACH: UPPER DON RIVER
PRECIPITATION CONDITIONS: 10 mm

	OPTION	CONCENTRATIONS (mg/l) PARAMETER SS	TP	AMMONIA	COPPER	LEAD	FC
1	STP UPGRADE	215	0.19	0.22	0.017	0.064	5000
2	STP REMOVAL	215	0.19	0.22	0.017	0.064	5000
3	CSO 90% REMOVAL	215	0.19	0.22	0.017	0.064	5000
4A	URBAN OFFLINE WET PONDS	128	0.12	0.19	0.011	0.020	4000
4B	URBAN/RURAL INLINE POND	44	0.11	0.17	0.010	0.019	4000
5	URBAN AND RURAL WET AND DRY MAINTENANCE	193	0.18	0.19	0.015	0.057	4000
6	URBAN AND RURAL WET AND DRY BMP	172	0.17	0.20	0.015	0.057	4000
7	URBAN FLOW CONTROL 60%	150	0.19	0.14	0.008	0.026	2000
8	URBAN OFFLINE PONDS AND FLOW CONTROL	115	0.12	0.13	0.006	0.009	2000
9	ALL (3-7) WITH STP REMOVAL	74	0.09	0.11	0.004	0.007	1000
	EXISTING	215	0.19	0.22	0.017	0.064	5000
	TARGET VALUE	200	0.10		0.005	0.025	100

DON RIVER REACH: MIDDLE DON RIVER
PRECIPITATION CONDITIONS: 10 mm

CONCENTRATIONS (mg/l) PARAMETER SS	TP	AMMONIA	COPPER	LEAD	FC
229	0.32	0.28	0.030	0.125	12000
229	0.32	0.28	0.030	0.125	12000
228	0.31	0.27	0.030	0.123	9000
60	0.18	0.23	0.019	0.039	11000
47	0.18	0.23	0.019	0.039	11000
207	0.29	0.25	0.027	0.113	11000
203	0.29	0.26	0.027	0.113	11000
102	0.17	0.13	0.014	0.052	7000
34	0.11	0.11	0.009	0.018	7000
24	0.06	0.08	0.006	0.012	3000
229	0.32	0.28	0.030	0.083	12000
200	0.10		0.005	0.025	100

DON RIVER REACH: UPPER DON RIVER
PRECIPITATION CONDITIONS: 20 mm

	OPTION	CONCENTRATIONS (mg/l) PARAMETER SS	TP	AMMONIA	COPPER	LEAD	FC
1	STP UPGRADE	231	0.20	0.23	0.018	0.069	5000
2	STP REMOVAL	231	0.20	0.23	0.018	0.069	5000
3	CSO 90% REMOVAL	231	0.20	0.23	0.018	0.069	5000
4A	URBAN OFFLINE WET PONDS	138	0.12	0.20	0.011	0.022	4000
4B	URBAN/RURAL INLINE POND	47	0.10	0.19	0.011	0.021	4000
5	URBAN AND RURAL WET AND DRY MAINTENANCE	208	0.18	0.21	0.016	0.062	4000
6	URBAN AND RURAL WET AND DRY BMP	131	0.12	0.17	0.009	0.016	3000
7	URBAN FLOW CONTROL 30%	196	0.20	0.19	0.013	0.048	4000
8	URBAN OFFLINE PONDS AND FLOW CONTROL	84	0.08	0.12	0.009	0.017	3000
9	ALL (3-7) WITH STP REMOVAL	84	0.08	0.12	0.007	0.012	2000
	EXISTING	231	0.20	0.23	0.018	0.069	5000
	TARGET VALUE	200	0.10		0.005	0.025	100

NOTES: UNITS FOR FECAL COLIFORM ARE counts/100ml.

DON RIVER REACH: MIDDLE DON RIVER
PRECIPITATION CONDITIONS: 20 mm

CONCENTRATIONS (mg/l) PARAMETER SS	TP	AMMONIA	COPPER	LEAD	FC
239	0.33	0.29	0.031	0.130	13000
239	0.33	0.29	0.031	0.130	13000
238	0.31	0.28	0.030	0.128	9000
62	0.18	0.24	0.019	0.041	11000
49	0.18	0.24	0.019	0.041	11000
215	0.30	0.27	0.028	0.118	12000
49	0.14	0.18	0.014	0.013	9000
173	0.25	0.22	0.022	0.092	11000
45	0.12	0.14	0.015	0.031	6000
35	0.09	0.13	0.011	0.022	5000
239	0.33	0.29	0.031	0.088	13000
200	0.10		0.005	0.025	100

TABLE 17

DON RIVER REACH: LOWER DON RIVER
PRECIPITATION CONDITIONS: 10 mm

		CONCENTRATIONS (mg/l)					
		PARAMETER					
	OPTION	SS	TP	AMMONIA	COPPER	LEAD	FC
1	STP UPGRADE	224	0.36	0.38	0.032	0.128	20000
2	STP REMOVAL	223	0.35	0.30	0.031	0.126	20000
3	CSO 90% REMOVAL	220	0.32	0.42	0.030	0.121	10000
4A	URBAN OFFLINE WET PONDS	59	0.23	0.41	0.021	0.045	17000
4B	URBAN/RURAL INLINE POND	48	0.23	0.40	0.021	0.044	17000
5	URBAN AND RURAL WET AND DRY MAINTENANCE	202	0.34	0.43	0.029	0.116	18000
6	URBAN AND RURAL WET AND DRY BMP	199	0.34	0.43	0.029	0.116	18000
7	URBAN FLOW CONTROL 60%	100	0.21	0.31	0.016	0.056	14000
8	URBAN OFFLINE PONDS AND FLOW CONTROL	34	0.16	0.29	0.011	0.023	13000
9	ALL (3-7) WITH STP REMOVAL	22	0.06	0.08	0.006	0.012	3000
	EXISTING	224	0.37	0.46	0.032	0.128	20000
	TARGET VALUE	200	0.10		0.005	0.025	100

DON RIVER REACH: MASSEY CREEK
PRECIPITATION CONDITIONS: 10 mm

		CONCENTRATIONS (mg/l)					
		PARAMETER					
	OPTION	SS	TP	AMMONIA	COPPER	LEAD	FC
1	STP UPGRADE	229	0.44	0.36	0.036	0.144	36000
2	STP REMOVAL	229	0.44	0.36	0.036	0.144	36000
3	CSO 90% REMOVAL	220	0.32	0.27	0.031	0.128	12000
4A	URBAN OFFLINE WET PONDS	54	0.29	0.31	0.024	0.056	34000
4B	URBAN/RURAL INLINE POND	54	0.29	0.31	0.024	0.056	34000
5	URBAN AND RURAL WET AND DRY MAINTENANCE	207	0.41	0.34	0.033	0.132	35000
6	URBAN AND RURAL WET AND DRY BMP	207	0.41	0.34	0.033	0.132	35000
7	URBAN FLOW CONTROL 60%	98	0.27	0.21	0.018	0.069	30000
8	URBAN OFFLINE PONDS AND FLOW CONTROL	28	0.21	0.19	0.014	0.034	30000
9	ALL (3-7) WITH STP REMOVAL	15	0.07	0.08	0.009	0.014	5000
	EXISTING	229	0.44	0.36	0.036	0.144	36000
	TARGET VALUE	200	0.10		0.005	0.025	100

DON RIVER REACH: LOWER DON RIVER
PRECIPITATION CONDITIONS: 20 mm

		CONCENTRATIONS (mg/l)					
		PARAMETER					
	OPTION	SS	TP	AMMONIA	COPPER	LEAD	FC
1	STP UPGRADE	235	0.37	0.36	0.033	0.135	22000
2	STP REMOVAL	235	0.36	0.32	0.032	0.134	22000
3	CSO 90% REMOVAL	231	0.32	0.36	0.030	0.126	10000
4A	URBAN OFFLINE WET PONDS	62	0.23	0.35	0.021	0.047	20000
4B	URBAN/RURAL INLINE POND	51	0.23	0.35	0.021	0.047	20000
5	URBAN AND RURAL WET AND DRY MAINTENANCE	212	0.35	0.38	0.030	0.122	21000
6	URBAN AND RURAL WET AND DRY BMP	49	0.19	0.29	0.016	0.036	18000
7	URBAN FLOW CONTROL 30%	170	0.29	0.33	0.024	0.097	19000
8	URBAN OFFLINE PONDS AND FLOW CONTROL	43	0.13	0.18	0.015	0.032	7000
9	ALL (3-7) WITH STP REMOVAL	33	0.09	0.13	0.010	0.022	5000
	EXISTING	235	0.37	0.40	0.033	0.135	22000
	TARGET VALUE	200	0.10		0.005	0.025	100

DON RIVER REACH: MASSEY CREEK
PRECIPITATION CONDITIONS: 20 mm

		CONCENTRATIONS (mg/l)					
		PARAMETER					
	OPTION	SS	TP	AMMONIA	COPPER	LEAD	FC
1	STP UPGRADE	236	0.48	0.41	0.038	0.153	45000
2	STP REMOVAL	236	0.48	0.41	0.038	0.153	45000
3	CSO 90% REMOVAL	224	0.32	0.28	0.031	0.131	13000
4A	URBAN OFFLINE WET PONDS	58	0.33	0.35	0.026	0.064	43000
4B	URBAN/RURAL INLINE POND	58	0.33	0.35	0.026	0.064	43000
5	URBAN AND RURAL WET AND DRY MAINTENANCE	214	0.45	0.38	0.035	0.141	44000
6	URBAN AND RURAL WET AND DRY BMP	45	0.29	0.29	0.020	0.052	41000
7	URBAN FLOW CONTROL 30%	169	0.39	0.33	0.029	0.115	43000
8	URBAN OFFLINE PONDS AND FLOW CONTROL	37	0.14	0.14	0.015	0.033	9000
9	ALL (3-7) WITH STP REMOVAL	26	0.10	0.14	0.011	0.024	8000
	EXISTING	236	0.48	0.41	0.038	0.153	45000
	TARGET VALUE	200	0.10		0.005	0.025	100

NOTES: UNITS FOR FECAL COLIFORM ARE counts/100ml.

APPENDIX B

BACKGROUND TO COST ESTIMATES

BACKGROUND TO COST ESTIMATES

Cost estimates and average sizes based, in part, on work carried out in TAWMS "Feasibility Study and Costing of Proposed Pollution Control Measures in Humber Sewershed - Task 4".

Off-Line Wet Ponds - Existing Areas

average drainage area = 120 ha
cost/m^3 = \$50 (construction)
cost/m^3 = \$60 (appertanences; i.e. road access, control structure, outfall constr.)
average depth = 2m
land requirement = 0.005 ha/ha (from NURP)
number of ponds = 200
land cost = 250,000/ha (averaged; based on floodplain, parkland, and residential land)

volumes: 5 mm rain = 1 mm runoff = 10 m^3/ha. (see Document 1)
10 mm rain = 2.8 mm runoff = 28
20 mm rain = 6 mm runoff = 60

Cost estimates/facility (20 mm event)

20 mm event

$60 \frac{m^3}{ha} \times \$110/m^3 \times 120 \text{ ha} = \$792{,}000 \times 200 \text{ ponds} = \$160{,}000{,}000$

$60 \frac{m^3}{ha} \times \frac{1}{2 \text{ m deep}} = \frac{30 \text{ } m^2}{\text{ha drainage area}}$

$30 \frac{m^2}{\text{ha drain area}} \times 120 \text{ ha} = 3{,}600 \text{ } m^2/\text{facility}$

$3{,}600\ m^2 \times \frac{ha}{10{,}000\ m^2} \times \frac{\$250{,}000}{ha} = \$90{,}000/pond$

x 200 pond = $18,000,000
x 3 to account for access/grass, buffer zone, etc. = $54,000,000

Total = 160 + 54 = $214 mill; use $250 mill

Disinfection

Assumptions: U-V treatment

Design Standards

5 mm event - 1 mm runoff = 0.001 m/day x 120 ha/facility = 1,200 m^3/day/facility
10 mm event - 2.8 mm runoff = 0.001 m/day x 120 ha/facility = 3,360 m^3/day/facility
20 mm event - 6.0 mm runoff = 0.001 m/day x 120 ha/faciilty = 7,200 m^3/day/facility

Capital Costs - hydro, service building, appertanences (based upon article: "Disinfection of Low Quality Wastewaters by Ultraviolet Light Irridation". These values are more up to date than those given previously in "Feasibility Study and Costing of Proposed Pollution Control Measures in Humber Sewershed - Task 5" which gave the following cost estimates:

Construction Cost	$200,000/cms
U-V Light Costs	$150,000/cms
Total	$350,000/cms

Capital Cost

5 mm event= $200,000/facility or $40 million (based on 200 facilities)
10 mm event = $250,000/facility or $50 million
20 mm event = $300,000/facility or $60 million

Operation and Maintenance Cost/Year

5 mm event = $15,000/facility or $3 million
10 mm event = $20,000/facillty or $4 million
20 mm event - $30,000/facility or $6 million

Total Annual Cost		Total Amortized Cost	
5 mm event =	$5.4 million	5 mm event =	$ 90 million
10 mm event =	$7.0 million	10 mm event =	$120 million
20 mm event =	$9.6 million	20 mm event =	$180 million

Assuming that U-V facilities are only used during the swimming season (100 days), and an average interevent period of 4 days (hence 25 events in this period), the U-V facilities would be used only 25-100 days per year dependent upon whether they were operated during the day of the event or continually. Hence, annual costs are 25/365 to 100/365 of the O and M costs indicated above.

Hence, the following costs result:

	Total Annual Cost for:		Total Amortized Cost for:	
Event	25 d/yr.	100 d/yr.	25 d/yr.	100 days/yr.
5 mm	$2.6 million/yr.	$3.2 million/yr.	$50 million/yr.	$60 million/yr.
10 mm	$3.3 million/yr.	$4.1 million/yr.	$60 million/yr.	$70 million/yr.
20 mm	$4.0 million/yr.	$5.3 million/yr.	$70 million/yr.	$90 million/yr.

Use range of 3-6 million/yr. for estimation purposes.

Combined Sewer Overflow - Treatment & Storage

Costs based on "Feasibility Study and Costing of Proposed Pollution Control Measure in Humber Sewershed - Task 1" and "Humber Sanitary Trunk Sewer System and Treatment Plant Study".

Based on 1 overflow event/year

storage volume = 150,000 m^3
storage cost = \$300/m^3
Total = \$45,000,000

* includes capital, operation and maintenance costs.

treatment costs - assumes secondary treatment required

Cost = \$2.5 million/MGD of capacity (Humber Sanitary Trunk Sewer System & Treatment Plant Study)

volume = 37 MGD
total = \$93 million
use \$100 million

North Toronto STP

Costs based upon Option 1(b) "Retain Plant; 7.5 MGD upgrade" including sludge disposal at Main Treatment Plant.

Cost estimates are taken from (Gore and Storrie, 1987: Study of the Future of the North Toronto Treatment Plant, Table 1), present operating data, and historical data.

Capital Costs for Plant - \$34 million (1987).

Associated Sewer System Improvements 4 million.

Use \$40 million in round numbers for 1989 for Capital Cost Annual Costs.

- Annual Capital Works Budget - \$1.2 million (1989).
- O and M \$1.5 million (1989 budget).
- Gore and Storrie Estimate for Option 1(b) - \$1.9 million.
- Use \$2.2 million to provide for some capital improvement annually but requiring less due to upgrade.

Additional Capital Costs (not included in options considered in this report).

- o Control of Effluent Turbidity by Filtration - $4 million.
- o Achievement of Nitrification - $7.3 million.

Assume Option 1(b) with nitrification to consider options of this study. Hence, capital = $50 million (round up) and O and M = $2.2 million/year; and annual cost = $5.2 million/yr.

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